

Dual Applicators for Non-Atomized Conformal Coating Improve High-Volume Manufacturing

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Atomized spray is the most common method for applying conformal coating. It disperses the material into a fine mist. Non-atomized coating, or selective coating, controls the coating material's dispense shape while maintaining the original liquid form. Selective coating coats specific components or areas of a board while respecting keep-out zones (KOZs). It increases transfer efficiency, selectivity, throughput, yield, and reduces masking and rework. The goal in high-volume manufacturing is to optimize the dispensing set-up to improve dispense quality, process control, reliability, and repeatability, while reducing material costs. To achieve high quality, accurate, repeatable coating with efficient throughput, non-atomized coating, instead of atomized coating, is used.



Selective coating can be applied to a broad area with a film coating applicator to achieve dispensing passes up to 750mm/second with clean edge definition or apply precision coating of discrete dots using a jet valve. If both are used on the same platform, manufacturers can create conformal coating programs that maximize control, reduce waste, increase throughput, selectively coat, and reduce rework. Adding process controls to an automated system provides accountability with traceability and process parameter maintenance.

Non-Atomized Coating Methods

Non-atomized dispensing methods include film coating, needle dispensing, and jetting. All these work well with solvent-based materials, which are used to improve transfer efficiency, selectivity, and throughput. Typical cured thicknesses for solvent-based

acrylics and urethanes are 25-75 μ m (1-3 mils) in a single pass. Thickness is specified by IPC standards and can be controlled by hardware, line speed, and viscosity. The amount of solvent added to the solvent-based material creates the desired thickness.

Non-atomized coating methods mold the fluid shape to obtain selectivity, clean edge definition, and ensure desired dispense volumes. They provide a higher wet-dispense accuracy without overspray. While all three methods are selective, they each provide a different degree of selectivity, so complex boards can often benefit from using a combination of these applicators.

Film Coater

A film coater dispenses in two distinct shapes. The primary shape is a leaf pattern that is made with a cross-cut nozzle to establish a fan-shape pattern that dispenses a curtain of material as the applicator moves. At the perpendicular angle, the dispense pattern is a knife edge that sets the pass edge on the substrate. Dispense pass width can range from 3-15mm, though typical dispense passes are ~10-12mm wide. The shape enables the placement of significant quantities of fluid in broad, wide passes that are ideal for low-profile, surface mount populated boards. With low components, the applicator can sweep across the board at speeds up to 750mm/sec. Figure 1 illustrates the pattern and dispense shape.



Figure 1. Film or Curtain Coater.

The film coater does have a few restrictions. The applicator is limited to solvent-based materials with an optimized viscosity. While selective, the film coater dispenses large volumes of material. Low viscosity material may pool around leads and other components, thinning coverage in other areas. The movement of the fluid flow is subject to the material properties and the surface tension of the board. Due to the applicator's physical size, access around tall components is limited. Furthermore, tall components can obstruct the dispense fan, requiring additional passes for complete coverage.

Needle Dispensing

Needle applicators have a wider viscosity range than film coaters and can be used for complementary applications. Needle dispensing uses fluid reservoir pressure to push the material through a needle to form a narrow bead, working on time/pressure technology. The needle's uniform, narrower pattern shape enables contouring patterns, like circles or sharp 90-degree angles. Using a continuous path program routine can seamlessly smooth contour lines into a clean perimeter dispense. See Figure 2.



Figure 2. Needle applicator. Tip and coating pattern (left), top view of final pattern (right).

In some cases, needle applicators are used to dispense a dam or gel material to restrict material flow. Staking material, RTVs, and gels are commonly used to hold components or protect connector components from contamination by the regular coating material. While the time-pressure needle applicator is practical with a broad range of materials, it lacks precise volume control.

Jet Dispensing

A jet applicator has the finest volume control and positional accuracy so it can dispense discrete dots. These dots are spaced far enough apart to reduce the material volume applied, yet close enough to flow and provide conformal coating coverage. Lines are comprised of a series of dots that blend together. Parallel lines can create area coats. By controlling the volume of a single dot, the system controls the volume of material dispensed across lines and coating patterns. While a film coater or spray can cause material to flood or contaminate keep-out-zones, a jet dispenser can dispense into tight locations or close to a component in very thin lines without exceeding the KOZs. See Figure 3.



Figure 3. Jet applicator with needle extension. Tip and coating pattern (left), top view of possible patterns (right).

Pairing Applicators for Dual Applicator Operation

Needle and jet applicators can be paired with film applicator non-atomized coaters to gain the full benefit of dual applicators in high-volume electronics manufacturing. Dispense needles are available in different gages, lengths, and shapes to best aid the application. The variety of tip options allows both jet and needle applicators to have accessibility around tall components and can provide narrower dispense widths. The flexibility of the applicator allows for finely tuned conformal coating dispenses.

By pairing a film coater with a jet or needle-type applicator, conformal coating programs can take advantage of the film coater's speed and broad passes while the paired applicator provides finesse, accessibility, and better access around vertical components. A jet applicator has the most volume dispense control, and the jet's precision reduces masking and rework. When the process is run by primarily using the film coater and pairing it with the jet's detail work, cycle time may be improved over a spray applicator moving at ~200mm/sec. A dual applicator set-up allows the operator to dispense the border around key KOZs and proceed to the larger volume dispense applicator within the same program. Dual-valve pairing enables high-volume manufacturers to create conformal coating programs that maximize control and selectivity, increase throughput, and reduce waste and rework

On an automated conformal coating system, applicators are situated on the machine and the system can toggle the appropriate applicator as the program calls for it. Additionally, the applicators have various tilt and rotate options to further flexibility. Ultimately, a well-rounded automated coating system requires process controls to provide parameter maintenance.

Figure 4 illustrates a coating program utilizing a dual applicator set-up to coat a board requiring large area coverage and fine detail work.

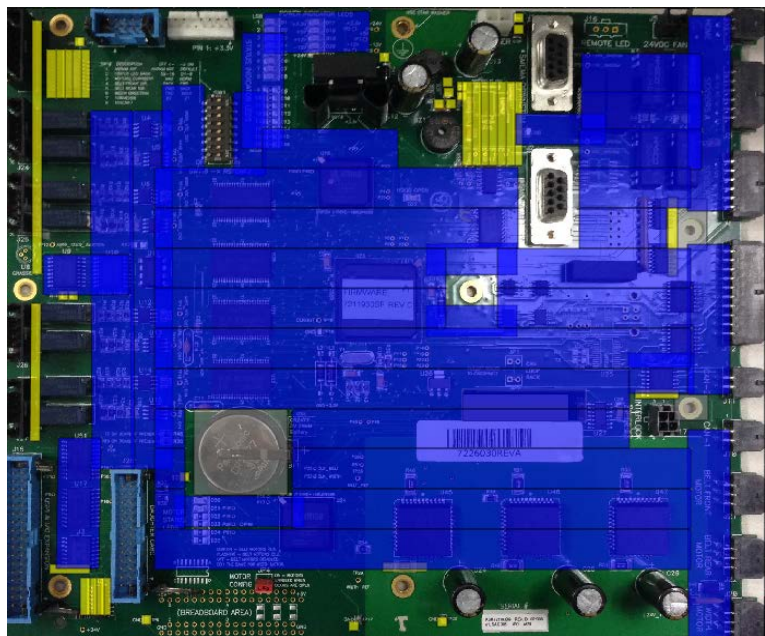


Figure 4. An image of a conformal coating program showing the dual applicator dispense. The blue pattern is the film coater area and the yellow is the detail work of the jet applicator.

Closed-Loop Process Controls for Conformal Coating

Automated conformal coating systems often have software that manage automatic maintenance routines and provide closed-loop process controls for single and dual applicator set-ups. These controls further improve performance and help ensure quality during high-volume production.

Dispense volume can be controlled through the software by modifying pulse-width modulation, which allows the operator to determine how long the applicator is opened and closed. The timing controls adjust the amount of material passing through the valve and the jetting actuation accelerates the fluid to break off. The capability of dispensing discrete dots distinguishes the jet from a needle dispense, which opens and uses fluid reservoir pressure to push the material through the needle. Dot spacing can be controlled by timing or spacing distance. Appropriate spacing reduces splashing by not placing wet dots on top of each other.

Employing a viscosity control system maintains consistent coating despite temperature fluctuations in the production facility. By heating the material, fluid temperature remains consistent throughout the day and can reduce bubbles in the substrate coating. The viscosity control system works best with low-viscosity fluids dispensed with a film coater.

When dispensing with a film coater, maintaining the material's shape and width is critical for uniform dispensing. Multiple factors can alter the dispense pattern, whether a change in viscosity caused by environmental temperature changes or an obstruction at the nozzle. A laser fan width control system can help maintain a consistent fan width throughout production. A laser is used to measure the width of the fan pattern at the dispense gap distance from the nozzle bottom. If the fan measures outside the specified tolerance, the system adjusts the fluid pressure to best meet the required dimensions. Using an on-board laser fan width control system can measure the fan width at programmed intervals during a production run.

If using needle or jet applicators, a needle-finder sensor can quickly determine the needle position. When changing needles or after an impact, the needle finder compensates for offset adjustments or can recognize that the needle is bent out of alignment. If the needle is bent, the material cannot dispense in a clean stream straight down from the needle, reducing the quality of the process. The needle finder can be used with needle dispense applicators as well as the jet applicator with needle extension.

Summary

Conformal coating is used in high-volume electronics manufacturing for the automotive, computer, communications, and consumer product manufacturing markets. A large portion of those applications require solvent-based coatings, which lend themselves to non-atomized application.

The non-atomized approach, as compared to atomized spraying, provides superior edge definition, higher coating speeds, more precise and accurate application, and single-pass coverage. The finer edge definition accommodates tighter keep-out zones while reducing or eliminating the need for masking. The film coater's faster line speeds and single-pass coverage translate to higher UPH. With the addition of a dual non-atomized applicator, the system can also selectively coat smaller areas that might otherwise be impossible to coat without using a mask. For high-volume manufacturers, automated selective coating systems provide an in-line, fully hands-off process that reduces or eliminates product handling by the operators, protects the coated products, and optimizes UPH and repeatability.

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