Advances in Jet Dispensing for Flat Panel Applications

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Abstract
As the demand for OLEDs increases, manufacturers are investigating methods to improve the speed and quality of the production process. One process step, the dispensing of UV seals on glass substrates, can be significantly improved with the utilization of jet dispensing. This paper describes the recent improvements of this technology and its benefits for applying UV seals.

Jetting Benefits
The use of jetting fluid dispensing technology is gaining popularity in the manufacture of Flat Panel Displays (FPD). Jetting has demonstrated increased throughput, improved yields, and simpler setup for this industry. Most of the throughput gains are realized from faster dispensing line speeds. The maximum velocity the jet can move while dispensing dots is not limited by the wetting of the fluid to the glass substrate as it is with needle dispensing. This is due to the different mechanism for separating fluid from the applicator. The jet uses droplet momentum and the needle uses the wetting adhesion. This also means that jetted lines can not exhibit the “roping” or “corner drag” failures associated with needle dispensing.

In addition to throughput improvements, jetting is a very robust process. If plasma cleaning of the glass substrate isn’t consistent, needle dispensing will have yield excursions. The symptom can be observed as acceptable dispense quality in one region of a glass substrate but not in another. Since jetting is not affected by the glass to fluid adherence, jetting is immune to this failure.

Further, jetting is a digital instead of an analog process. This means the dots are dispensed in the correct position regardless of the speed or acceleration of the dispensing XYZ positioner. The issue of “pooling” fluid in the corner of a rectangular dispense pattern (as the machine decelerates, changes direction and accelerates) does not occur with jetting.

Finally, machine setup is simplified since the quality of the jetted dot is not affected by a wide variation in dispense gaps (1 mm). Local glass surface flatness, tooling planarity and height sense accuracy have no measurable affect on jet dispense quality. This removes a significant setup burden from machine operators especially when working through glove boxes.

Throughput Improvements
To measure the latest throughput improvements, five machine configurations were compared. This comparison was performed on a Generation 4 glass substrate with 899 UV seals and the results are shown in Figure 2.

Figure 2- Processing Time (minutes) for a Generation 4 glass substrate.

A twin jet configuration is 30% faster than a quad needle configuration. New jetting technology (Jet+) and a strafing pattern yield the fastest throughput in the comparison. Jetting is clearly an enabling technology for enhancing UV seal production rates.
Strafing is a new method to enhance throughput. The method dispenses all of the horizontal lines followed by the vertical lines. This eliminates a significant portion of time used to accelerate and decelerate that occurs when dispensing one seal at a time.

Figure 3- Strafing Pattern. Dotted lines indicate non-dispensing motion. The motion on straight lines is continuous between dispense and non-dispense segments.

Figure 4- Traditional Dispensing Pattern. The machine accelerates and decelerates 4 times for each seal. Dotted lines indicate non-dispensing motion.

**Process Control Improvements**

A new technique has been introduced to improve process control for jetting. This technique, known as Calibrated Process Jetting, enables the machine to automatically monitor the jet’s mass flow rate and then self adjust to compensate for variations. The result of this technique is much higher precision for the total mass (volume) of fluid being dispensed. Given a sufficient number of dots, volume accuracies better than 5% are achievable.

Figure 5 shows changes in mass flow for traditional and improved jetting hardware as the jet is cycled with Nagase XNR 5570 over time. The graph of the traditional hardware suggests scheduling maintenance every three million cycles of usage. The graph for the new hardware suggests the maintenance interval can be extended more than three times that of the traditional.

Figure 6 shows the results when process control corrects for the mass flow variations seen in Figure 5. This allows a much longer interval between maintenance and a higher dispense accuracy.

**Summary**

Jetting technology continues to improve and is demonstrating its distinct production advantages for dispensing FPD UV seals. Jetting’s ability to improve throughput, widen process windows and enhance the quality of UV seals is unique.

As engineers take advantage of the digital attributes of the jet, new and previously unfeasible dispense patterns are being realized. These patterns reduce the demands on the positioning system while improving throughput.

New methods of adding process control are further enhancing the precision for jetting technology.