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Jetting: Dispense Technology of Choice for Adhesives

Many manufacturers choose jetting technology to meet the demands of automated adhesive application processes. As more manufacturers in a variety of industries become aware of its advantages, jetting will become increasingly popular as the dispense technology of choice for adhesives.

By Al Lewis

Many manufacturers today choose jetting technology to meet the demands of their automated adhesive application processes. Companies currently use jetting for corner-attach bond, chip-stack packages (CSP), flip chip, no-flow, and pre-applied underfill applications, as well as conductive, surface mount, UV-cure adhesives, and silver epoxy. Because jet technology represents a paradigm shift from needle dispensing, it is becoming more popular as the chosen dispense technology for adhesives. Some reasons for this shift include:

- A jet dispenses material in smaller spaces than a needle.
- Underfills have smaller fillets with jetting for both BGA and flip-chip on-board applications.
- Jetting is gentle on wire bonds and other delicate assemblies.
- In contrast to jet printers, which are limited, automated jet dispensers can apply specific fluids or viscosity ranges.
- The particular dispense characteristics of adhesives and the range of adhesive applications makes jetting attractive for high-volume production.
- Jetting is an enabling technology for adhesive dispense on cutting-edge designs.
- Jetting offers low cost of ownership compared to other adhesive dispense methods.

A Jetting Primer

Current dispense jetting technology uses a mechanically, electrically, or pneumatically actuated piston with a ball tip to impel fluid through a narrow orifice at the end of the jet nozzle (Figure 1). Air pressure raises the piston, allowing fluid to flow around it into the nozzle. When air pressure is removed, a spring returns the piston so the ball again sits in the nozzle orifice. As the ball re-seats, it shoots a droplet of fluid out the end of the nozzle. Adjusting the nozzle orifice, air and fluid pressure control droplet size. Precise heat control at the nozzle maintains fluid temperature at an optimum viscosity for jetting, and reduces variation in production.

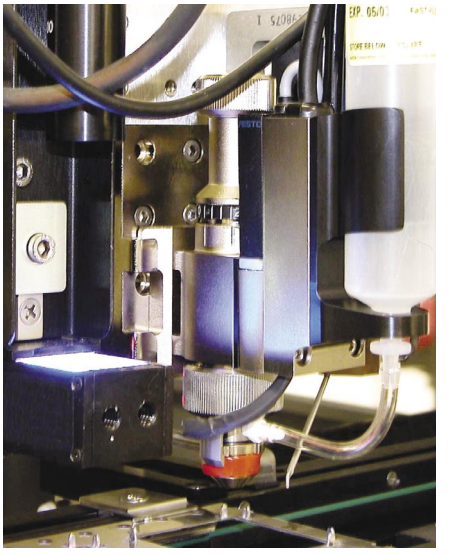

Figure 1. A pneumatic piston impels fluid through a narrow orifice at the end of the nozzle.

Small dots propelled from the jetting mechanism at rates up to 200 Hz in four software-controlled modes: distance-based, time-based, fixed number of dots per line, and continuous line with breaks, enable the construction of many different sizes and shapes of dots and lines. Because the momentum of the fluid comes from the jetting action, proximity to the substrate (dispense gap) is less critical than needle dispensing.

A complete technical description of jetting best illustrates its advantages over other dispense technologies, but even this brief introduction to the fundamentals of jet dispensing reveals several advantages over older adhesive dispensing methods.

Jetting is Versatile

Most adhesives that can be dispensed using a needle can be applied with jetting technology. An adhesive can be defined as any material that bonds two previously discrete items so the resulting bonded assembly can operate within the range of thermal and mechanical stresses that can be expected within the product's use.

Using this definition, many dispense processes may be understood to be adhesive applications. Some processes, such as die attach and stacked die, are obvious. Others, such as underfill or lid seals, may not be as obvious, but from the perspective of the dispense process, represent adhesive applications.

The inherent simplicity of the jetting mechanism enables it to adapt to a wider variety of adhesive fluids, dispense patterns, and circuit board geographies than is possible with a needle dispenser. This simplicity facilitates multiple adhesive application processes using a single jetting dispenser.

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Jetting is Faster for Adhesives

The most attractive feature of jetting with regard to adhesives is increased speed. The primary reason jetting is faster than needle dispensing is the reduced amount of mechanical travel required by the jet mechanism.

The accumulated speed advantages of jetting are summed up with the phrase "jet on the fly." Speed is the most obvious advantage of jetting adhesives, but the elements of jetting that generate greater speed also create other advantages.

Jetting is Non-contact Dispensing

To operate at high speeds, an automated needle dispenser often requires a standoff to provide dispense-gap feedback to the operating system. This contributes several potential negative outcomes:

1. Contacting the substrate with every dot will abrade the tip of the standoff post. This can cause process anomalies and downtime for equipment maintenance.
2. The standoff post can track small amounts of previously applied material onto other parts of the substrate.
3. Because the standoff post sometimes contacts previously applied material, it must be cleaned. This adds complexity to the mechanical and software components of the dispense process.
4. Contact of the standoff post can damage the board or substrate and knock components off a PCB.
5. Under-board support typically is required, adding cost and setup time.

Jetting eliminates these possibilities from the process.

Applying Adhesives into Small Spaces

Several factors restrict the amount of usable space available for a dispensing needle. Rapidly decreasing component size and shrinking real estate for placement challenge the capability of needle dispensers to apply adhesives quickly, accurately, and effectively. These limits are just as pronounced with screen-printing technology. Some examples of applications where jetting technology's ability to apply adhesives into tight spaces are:

- SMT applications where it is necessary to apply surface mount adhesives to an assembly after solder paste has been applied. Because of the jet nozzle's ability to fit into tight spaces, and because it can build up a dot quickly by applying many shots in the same location, surface mount adhesive can be applied after solder paste without disturbing the paste (Figure 2).
- 0402 component attach, where volumes of 10 nl and dots as small as ~13 mil are possible with jetting;
- Jetting through RF shields for BGA underfill;
- Jetting in cavities for MEMS assembly;
- Jetting underfill on boards with tight keep-out areas or to jet between closely spaced die (currently as tight as 350 µm).

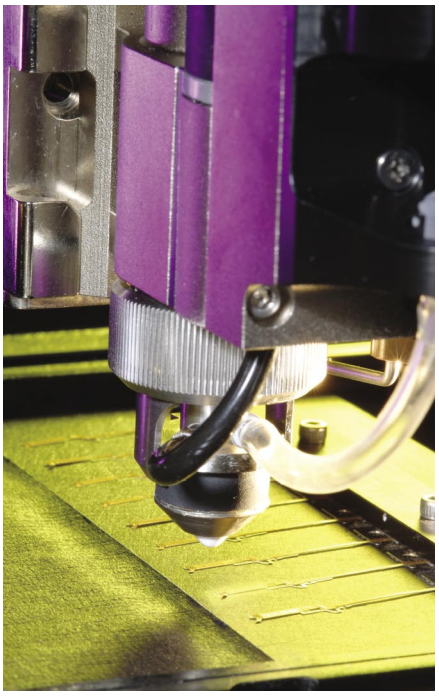

Figure 2. Jetting technology enables surface mount adhesive to be applied after solder paste without disturbing the paste.

Jetting as an Enabling Technology

Some of the latest designs in electronics packaging, medical devices, and telecommunications equipment make jetting an enabling technology — without which the manufacturing of these products would be impossible or too expensive to be marketable. Not only does jetting enable the manufacture of these products, it often can be accomplished using standard jetting equipment rather than custom-designed machines.

Typical applications in which jetting can enable untenable designs include die attach, assembling stacked die, producing cell phones that have an RF shield, and installing UV gaskets for LCDs. The speed improvement mentioned above can be as great as 1.5–6× with jetting.

A more vital consideration in favor of jetting adhesives for die attach, for example, is the ability to create patterns not possible with a needle dispenser. Another application that demands the unique patterns available with jetting is dispensing 3-D lines of silver epoxy onto MEMS sensors.

Jetting is Cost-effective

Several features of jetting technology lend themselves to cost efficiencies not achievable with other dispense methods. Jet dispense can produce a smaller wetted path than most pumps used for needle dispensing. Therefore, less fluid is wasted. Fewer machines are required with this technology because one model can handle multiple applications. Also, fewer moving parts mean fewer breakdowns, lower maintenance, less downtime, and fewer consumables. Jetting's ease of use requires less operator training. Jetting is non-contact dispensing, so it does not require underboard support. Lastly, cleaning requires minimal tools, and can be accomplished in ten minutes or less.

Conclusion

Increasing demands of the global manufacturing market for speed, accuracy, ease of use, and cost effectiveness in adhesive dispensing makes jetting technology more attractive than other dispense choices. In response to the demand for enhanced volumetric repeatability, one vendor* developed a feature that aims to improve process capability (C_{pk}). Dispense patterns are programmed with a specified weight, the system samples the dispense weight per shot periodically, and then computes the number of shots for each pattern. This information is used to optimize line-speed based on maximum-specified shot intervals.

Jetting is used in the assembly and packaging of cell phones, computer processors, MEMS devices, hybrid circuits, and a variety of surface mount PCBs and flex circuits. As designers become more familiar with the capability of jetting, they will design parts that can only be manufactured by use of jetting technology. Those that don't take advantage of the technology lose an opportunity to improve their products. SMT

For a complete list of tables, please contact the author.

*Calibrated Process Jetting (CPJ), Asymtek.

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