

Jetting of flux for flip chips

Steve Adamson

Tom Adams
Consultant

In flip chip assembly, the jetting of liquid flux material onto the substrate has advantages over the dipping of the attached balls into flux. One key advantage is an increase in line capacity that occurs because the dipping operation of the pick-and-place machine can be eliminated.

Several users of Asytmek's flux dispensers in plants in Taiwan have reported throughput increases of about 20 percent compared to dipping of the solder balls. Manufacturers have also found out that jetting lets them put down a much thinner flux layer—as thin as 5 μ —and leaves significantly less residue. These plants have also reported increased yield when using jetting, a result that has also been obtained by major assembly houses around the world.

As used on flip chip substrates, jetting sprays low-viscosity fluxes (typically 95 percent alcohol) onto a defined area of the substrate, with little overspray beyond the defined area. A 10-by-10mm chip requires only a 1mm border for overspray; and since adjacent bond pads and structures outside this border receive no spray, cleaning is therefore not required.

In dipping, the chip, with solder balls attached, is inverted and dipped into a thin layer of liquid flux on a plate. The thickness of the flux on the plate is controlled by a doctor blade that continuously sweeps around the plate to achieve a thickness of around 25 μ m to 50 μ m (.001 inch to .002 inch). Although dipping is a reasonably straightforward method, in volume production it has some weak points that may become problems. Although the layer of liquid flux on the plate is relatively thick, some balls on the chip may not receive any flux at all since solder balls vary in diameter. In dipping, some of the shorter balls may not make contact with the flux [Fig. 1]. As the chip is drawn downward during reflow, the

uncoated short balls may make physical contact with the bond pads, but they will not make good joints.

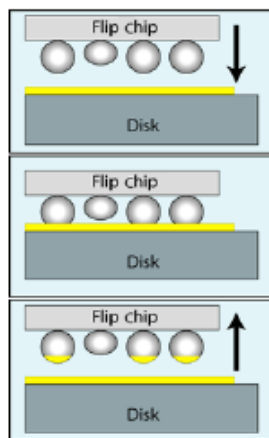


Figure 1: Dipping may leave short balls without flux.

In jetting, the flux is exposed to air only after it has been sprayed and is already in the desired location. But the flux on the dipping plate is continually exposed to air, and this exposure may cause additional problems. Dust particles that get into the flux layer may attach themselves to a short ball and prevent contact with the substrate. The layer of flux on the plate is continually drying out and must be refreshed to avoid increases in viscosity. If viscosity does become too high, the flux layer may become sticky and may begin to pull solder balls off of the chip.

Another comparison is that in dipping, the dipping plate must be stopped and cleaned about every four hours. Meanwhile, the recommended cleaning interval for the spray nozzle used in jetting is one week; but in practice, nozzles frequently operate successfully for months at a time without cleaning.

In some situations dipping may actually damage the solder balls. This may occur on flip chips where the distribution of the solder balls is uneven—say, where there is a concentration of balls near one edge of the chip. This arrangement is most likely to occur in flip chips that have been converted from a wirebond configuration.

Additionally, there is significant difference in the quantity of flux that is delivered onto the solder balls by jetting and by dipping. Dipping leaves a flux coating of about 25- to 30 μ m (about .001 inch) thick on the solder balls, while jetting can consistently put down a layer of flux as thin as 5 μ m (.0002 inch) on the substrate.

Avoiding excessive flux residue

Best practice calls for delivering the minimum quantity of flux that will prevent oxidation and promote bonding. Applying more flux than this means that there will be excessive flux residue. Flux residue is structurally weak, and is both expensive and difficult to remove completely. It is much more efficient to achieve precise control over flux quantity at the start.

The spraying of flux onto the substrate by the jetting technique gives much more precise control over flux quantity, and thus over flux residue. The jetting nozzle typically lays down a track of flux about 2.5mm wide. If the chip measures 10-by-10mm, the nozzle makes four passes to cover the whole area. A 1mm wide band around the area is also oversprayed, but there is no requirement to spray the whole area of the substrate.

Jetting is typically used with high-solvent fluxes (e.g., 95 per-

cent alcohol) that have very low viscosities. The micro-droplets fired by the nozzle may not flatten out immediately on contact because of surface tension with the substrate. But directly behind the nozzle is a coaxial air assist [Fig. 2] that causes the dots of flux to flow together and form the desired thickness. This is how jetting can achieve a uniform thickness of only 5 μ m, compared to the 25- to 30 μ m applied to the balls by dipping. The reduction of flux residue, compared to the volume of flux left by dipping, is about 40 percent.

The pattern of spraying is also designed to maintain an even thickness. On a 10-by-10mm substrate, for example, the nozzle makes four separate passes. At the end of each pass the nozzle is shut off, and moved laterally into position to begin the next pass. If the nozzle was not made to shut off, some areas would receive a double quantity of flux. More recently, it has become possible to employ a wider nozzle to dispense a spray pattern that is a full 10mm wide, so that a 10-by-10mm substrate can be covered completely in a single pass. This method makes time savings even greater.

Production engineers that use jetting to dispense flux have weighed the substrate offline after the spraying of lines to determine the flux thickness. Accurate weighing is somewhat difficult since the solvent evaporates as weighing is being carried out. Recently, an interferometer method has also been used in-line to measure flux thickness. Both of these methods gave similar results: that the flux itself was as thin as 5 μ m. In practice, users of jetting have concluded, after initial trials, that the process is robust and that attempting to measure the thickness is no longer necessary.

Although jetting is typically used with low-viscosity fluxes, it can also be used with higher-viscosity fluxes and even with paste fluxes. In the latter case, a different type of nozzle, designed to handle very high viscosity fluxes, shoots droplets that form lines and dots rather than a continuous film. |

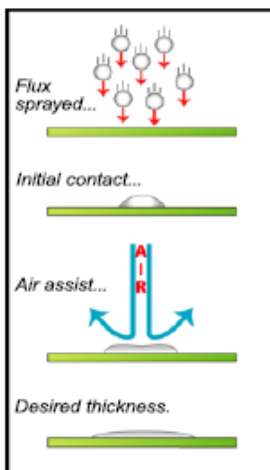


Figure 2: Coaxial air assist spreads the flux and helps achieve final thicknesses as thin as 5 μ m.