Jetting Dispensing of Fluxes for Flip Chip Attachment and

Measurement Methods for Ensuring Consistent Flux Coatings

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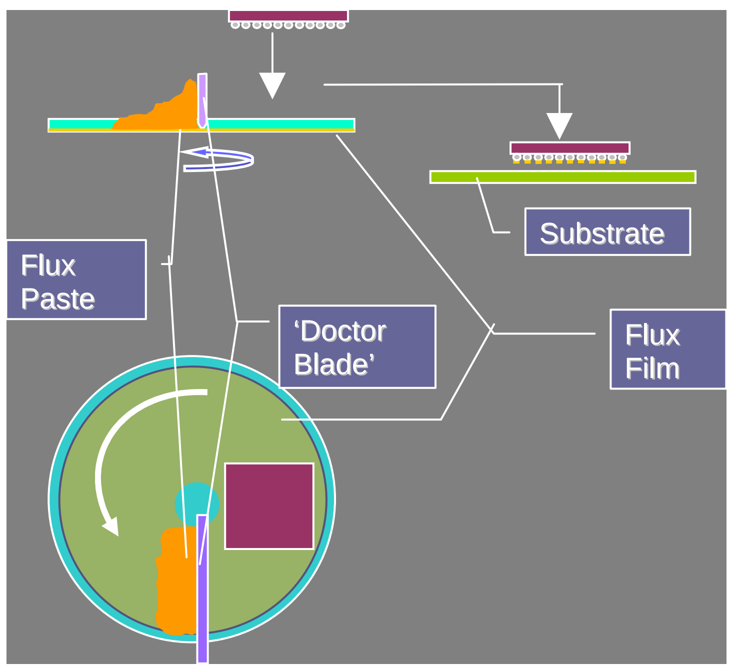
Applying flux to a die or board for flip chip assembly is typically realized by either dipping the die onto a flux coated plate or jet dispensing flux onto a board surface (ref 1).

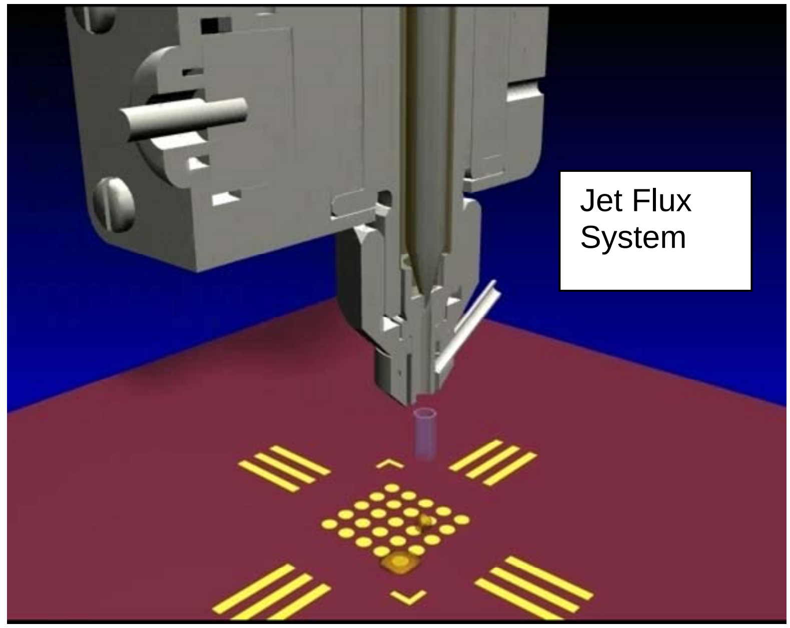
The goal of these techniques is to ensure an adequate supply of flux to aid the joint formation between the solder balls on the flip chip and the substrate. Too small an amount of flux will cause a poor joint, conversely too much flux can impede the flow of underfill fluids. Most dipping operations are performed in the die placement system, which slows down the throughput of the system.



Flux Dipping System

Dipping of die into a flux film to coat the bottom of the Flip chip solder ball can be problematic if balls do not all project down from the die to the same level. This can result in a ball without flux and a dry solder joint. Balls can also be damaged when placed dipped onto a flux coated plate.

By separating the flux application from the die placement operation, the speed of die placement system can be improved. It is estimated that a die placement system with a flux dipping system has a 20% reduction lower output compared to one without a dipping flux bath.



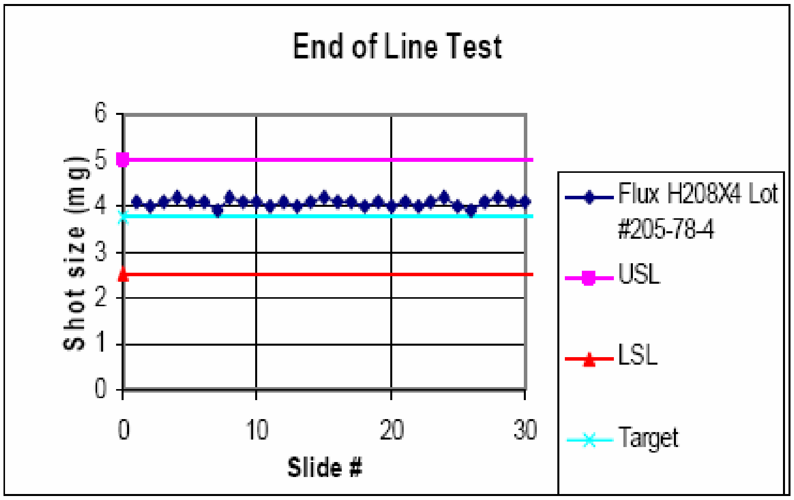
The jet flux dispensing system coats the PCB or package substrate with a thin layer of flux. This ensures that flux is available to all pad sites. When the package is reflowed surface tension will pull the die down and the pads with smaller bumps will contact and form a solder joint.

The picture to the right shows a cone in seat jet arrangement where flux is jetted from the nozzle using a combination of fluid and air pressure.. The cone provides excellent control of the flux volume and the coaxial air assist is used to help overcome the surface tension of the substrate and lower the overall flux film thickness.

This jet system can work with tacky flux materials but is primarily used with high solvent fluxes, typically 98% alcohol.

Through designed experiments with jet dispensing of flux (1), it has been found that coating the substrate with a thin film of flux approximately of 4 to 10 $\mu g/mm^2$**,** provides adequate substrate coverage for the flip chip process (ref 2). A film weight of 4 $\mu g/mm^2$ translates to a coating thickness of 5 microns for a flux with a density of 0.8kg/l. This coating thickness is dependant on the flux type and application. In many cases thicker flux layers of from 15 to 30 microns are often used. Generally the lower film thickness will give les flux residue after reflow.

Film thickness control must be maintained at process speeds of 2000 UPH. To date, process control has been performed off-line by weighing coated substrates. This has presented several problems as the flux is usually solvent-filled and it evaporates quickly following coating.



Target =	3.75	±	33.33	%
USL	LSL	UCL	LCL	
5.00	2.50	4.33	3.84	

Avg. Wt.	% diff.	Cp	Cpk	N
4.08	8.89%	5.139	3.769	100.00

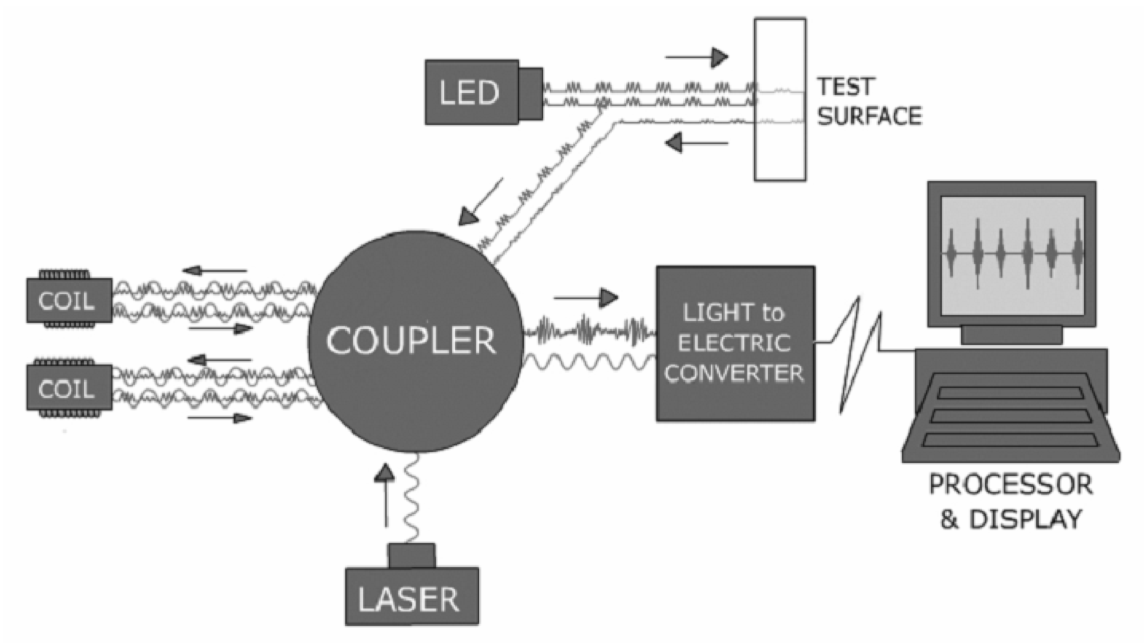
Stdev.	3 Sigma	3 Sigma%	Min	Max
0.081	0.243	5.96%	3.90	4.20

Flux jet test results

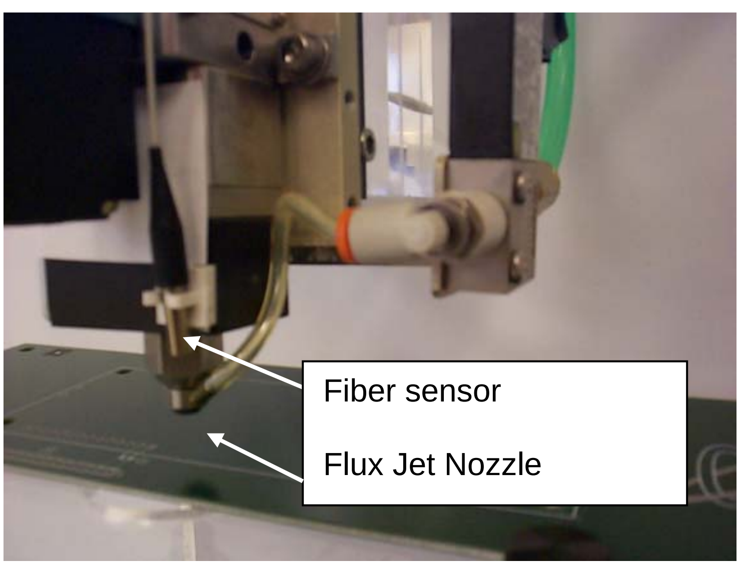
The above test results show that by weighing the substrates prior to and after jet dispensing the weight of the substrate can be used to verify the coating control. By dividing the weight and with area the film thickness can be obtained

Weighing is a fairly simple approach to quality control of film thickness. As the film becomes thinner and hence has less mass, its weight becomes difficult to measure, and sophisticated weigh scales are required. Complicating this is the fact that the flux film is 98% alcohol, that it is evaporating and it can be appreciated that under these conditions weighing is not easy. In addition weighing is an off line techniques that is not that convenient as in line measurement.

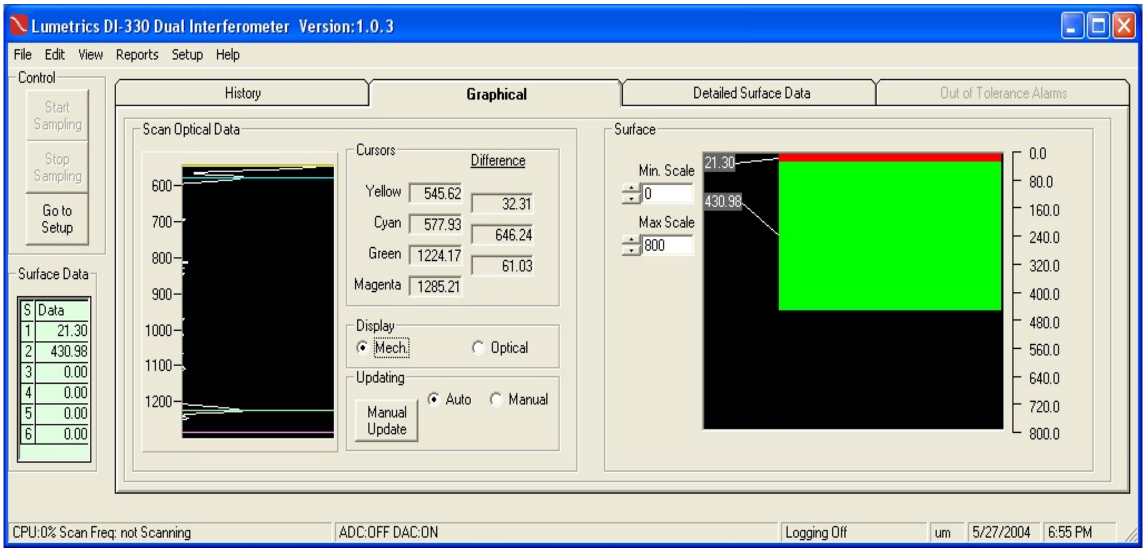
For these reasons we have been looking for an in-line measurement system that can measure a coating film thickness on a dull or matt substrate (like a PCB) and can do this in the coating cell. Interferometers usually require a bright surface to reflect enough light to get a reading. One product that has been developed is a unique dual-light interferometer that provides enough power to provide reflections in this environment. In this case, a system of coherent and non-coherent light is used to create and measure the flux thickness.



The figure above shows a non-coherent LED light shining on the surface of the test sample. At each interface surface, in this case the front and back of the flux, light is reflected from the surface back through the probe to an interferometer. These light signals are combined with a coherent laser light reference signal and are sent down fiber optic cable to piezo stretchers. The fiber is bonded to these piezo electric stretchers that are constantly being exercised. This produces an interference pattern within the original light reflections that is calibrated by the laser reference signal. This interference pattern is converted from light to electrical signals where a microprocessor can interpret the signals into thickness measurement.



In the image to the left the jet nozzle can be seen with the flexible pip supplying air for the coaxial assist. The fiber optic sensor is attached to the front of the jet and focused just behind the jet nozzle to measure the as deposited film. The control electronics operates at 1 KHZ and multiple fiber sensors can be used to scan the several points in the dispensed area. An alternative arrangement uses a galvanometer type of movement to scan the complete area. The problem of measurement then becomes one of data handling and decision trees would have to be built, to determine if the part continues in the process line.



The above screen print shows a 21 micron flux coating and an additional solder mask board coating of approximately 430 microns.

Results so far have accurately measured flux films in the 20 to 50 micron thickness, with an accuracy of 0.2 microns and a resolution of 30nm. The Flux was standard Indium Corporation Indalloy flux. The system was verified using standard metrology gauge block comparator methodology both before and after testing.

While these measurements are working well with the thicker flux films the existing light source bandwidth of 45nm requires a thickness of at least 12-15 microns. Increasing the bandwidth to 100nm will allow measurement of flux in the region of 5 microns thick.

Summary: Jet flux dispensing is used by many of the large flip chip assembly houses. It is enabling these companies to achieve high throughputs with a better yield. The goal of this work was to find a measurement system that could measure line flux thickness and coverage. The Lumetrics measurement system [or the measurement system described above] has demonstrated in its present form it can be used to monitor film thickness in the 20 to 50 micron range. It is believed that with a suitable light source, flux films of 5 microns can be measured.

Reference:

1. Stefan Behler and Dominik Hartman "Comparison of Flux Application Methods for Flip chip Die Bonding" proceedings of Semicon Singapore, 2001

2. Raj N. Master etal, "Novel Jet Fluxing Application for Advanced Flip Chip and BGA/CGA Packages" proceedings of 50th Electronic Component and Technology Conference, 2000, pp 1185-1188