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Upgrading Die Attach Epoxy Dispensing Mechanism

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Authors' contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

This research paper addressed how to improve the Die Attach Pneumatic Time-Pressure Dispensing Valve. Different assessment and statistical validation comparing the efficiency of the Pneumatic Time-Pressure Dispensing Valve and Dispensing Volume Reduction. The Musashi Super Σ CMIII Dispenser with Sigma function controller provides more choices for regulating the volume of dispensing, since the residual material in the syringe decreases, and can be a more suitable method for dispensing glue. The consistency of the glue volume will be more consistent after the implementation of this update. This controller has the option to compensate for pressure and vacuum as the remaining fluid in the syringe decreases. The Musashi dispenser controller is equipped with an empty syringe detection system. As the remaining adhesive, this will avoid variations in dispensed volume.

Keywords: Die attach; epoxy dispensing; dispenser controller; pneumatic dispense; glue volume.

1. INTRODUCTION

The Die attach process, also known as die bonding, is the process of attaching (or bonding) a die (or chip) to a substrate, leadframe, or another die. This process can take on many forms and can be applied in many ways. The common die attach material is Epoxy.

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Epoxy Dispensed through dispensing needle or nozzle by controlled volume on the substrate. The location of the dispensing is controlled with the vision control system in the die attach equipment as illustrated in Fig. 1.

The Die attach material selection and process implementation play crucial roles in any microelectronic assembly. The chosen attach methods ultimately affect die stress, functionality, thermal management, and reliability of the assembly. The Die attach applications are designed to optimize mechanical attachment of the die to the substrate, to create a thermal path from the die to the substrate, and to create an electrical path for a ground plane connection. Some of the more commonly used die attach materials in the microelectronics industry today are epoxies, die attach film, and soft solders.

The most common method systems used in epoxy dispensing adhesives use a time pressure dispensing valve, auger pump, positive displacement pump, or a jetting valve. Each technique has its unique advantages and disadvantages [1].

Pneumatic Time-Pressure Dispensing Valve: The time-pressure dispensing valve (Fig. 2.) consists of a syringe containing adhesive which is directly attached to the dispensing tip. The adhesive is fed from the syringe using pressure in a time-controlled manner. The pressure is removed to stop material flow. Fluid flow is proportional to the amount and duration of the applied pressure. Since the air pressure is kept constant over time, as the syringe is emptied, dot sizes decrease because the plunger does not advance as far with each air shot. This variability can be adjusted by increasing the air shot size, but is often operator dependent and can lower throughput. Time-pressure systems are the most economical dispensing solutions, but have a lot of variation in their results, and are limited in the minimum dot size they can produce [1].

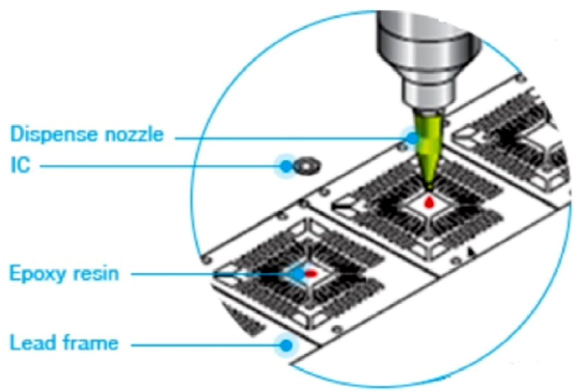


Fig. 1. Epoxy dispense

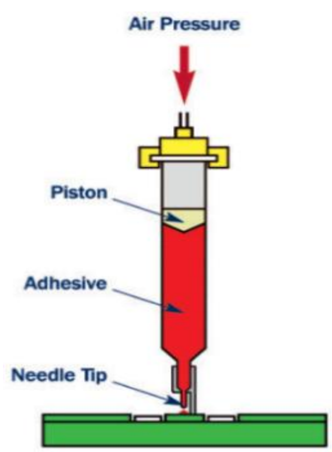


Fig. 2. Pneumatic time-pressure dispensing valve

2. PROBLEM IDENTIFICATION

Pneumatic Dispense (Fig. 3.) is Air pressure that forces the adhesive through the dispensing needle. The Limitation is the Speed affects consistency due to limited pressure supply and Viscosity dependence.

Using the current machine epoxy dispenser, the variations in the amount of dispensed glue were experienced. This variation can lead to different Bondline Thickness (BLT) and glue fillet height resulting in defective parts.

As the remaining volume in the syringe reduces, the amount of glue volume dispensed is reduced. Hence the pressure has to be increased to dispense the same volume with the machine buy-off was done. The current dispensing machine is not equipped with Auto to compensate.

3. METHODOLOGY

This evaluation aimed to compare the consistency of glue dispensed between a Pneumatic (pressure-time) dispensing and a Musashi Super Σ CMIII Dispenser controller. To achieve more accurate and precise dispensing control [2] based on Musashi Engineering Fully Digital Controlled Dispenser catalog.

Musashi Super Σ CMIII Dispenser Controller the pressure and vacuum through Air Pulse Stabilization Circuit. When Σ mode is turned on, the auto-correction function is already activated or automatic correction of volume reduction in dispensing amount caused by the effects of decreased syringe volume as illustrated in Fig. 4. Constantly maintains the optimum volume level automatically for more reliable dispensing precession [2] based on Musashi Engineering Fully Digital Controlled Dispenser catalog.

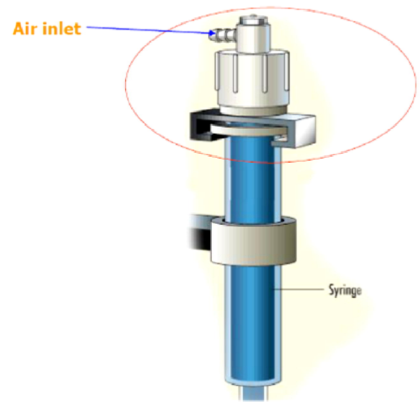


Fig. 3. Pneumatic dispense

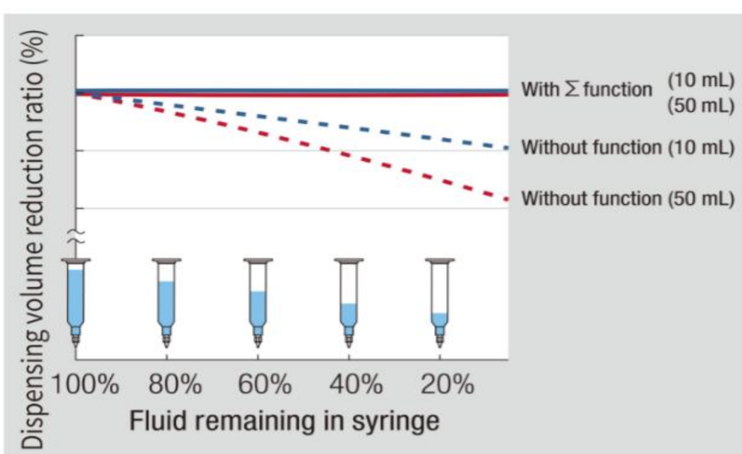


Fig. 4. Dispensing volume reduction

4. RESULTS AND DISCUSSION

Test 1: Data by lead frame using Timed mode function

Method: A preliminary test was carried out to check for dispensing consistency. The method used for this test was:

1. Eight raw lead frames were marked.
2. Each lead frame was weighted.
3. Glue was dispensed on four lead frames using the Pneumatic Time-Pressure Dispensing system.
4. The Musashi Super Σ CMIII Dispenser controller was then connected instead of the Pneumatic Time-Pressure Dispensing system and glue was dispensed on the remaining four lead frames.
5. Measure each glue weight in milligrams.

The difference in weight of glue between the Pneumatic Time-Pressure Dispensing system and the Musashi controller was not of major importance. This difference was a result of different glue weights or volume, over the time or syringe epoxy level, hence different glue fluctuations in dispensed volume as the remaining glue reaches the end of the syringe.

Better results for both range and variance were obtained when using the Musashi controller (Fig. 5). Compare with Pneumatic Time-Pressure Dispensing Valve (Fig. 6). This test was to measure the weight of one complete dispensed lead frame. More tests will be carried out to measure the weight of single positions to eliminate and fluctuations within the same lead frame.

Test 2: The procedure used for this test was similar to the method used for the previous test. However, instead of measuring the glue weight, we will measure the Bondline Thickness (BLT).

For this test, better BLT results were obtained using the Musashi controller for glue dispensing (Fig. 7.). Compare with BLT measurement obtained from Pneumatic Time-Pressure Dispensing system (Fig. 8.). This difference was a result of different glue volume, hence different glue fillet and bond line thickness between the two runs. Both runs were within specification limits.

In this exercise, it was noticed that Musashi dispenser controllers have performed appropriately. Very good data and small variations were observed resulting in high Process Capability (Cpk) computed (Fig. 9.) compare with the Pneumatic Time-Pressure Dispensing system (Fig. 10.) [3] guided by JMP Statistical Manual. The objective of this task, which was to compare the consistency ofglue dispensed with less variation.

Using Statistic tools Two-Sample T-test (Fig. 11.) [3] guided by JMP Statistical Manual were fined out, at 95% confidence level, there is a significant difference in BLT between Pneumatic Time-Pressure Dispensing system and Musashi Dispenser with P-value of <0.0001. The Means are statistically being different with a 26% variation in BLT.

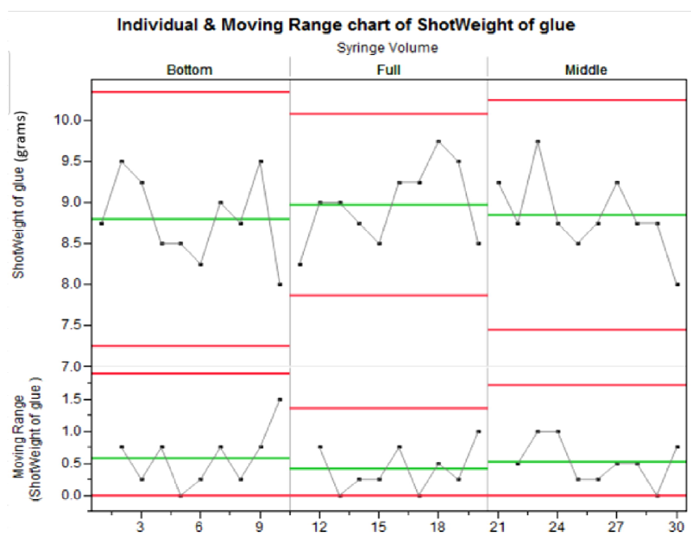


Fig. 5. Individual & moving range chart for Musashi super Σ CMIII dispenser

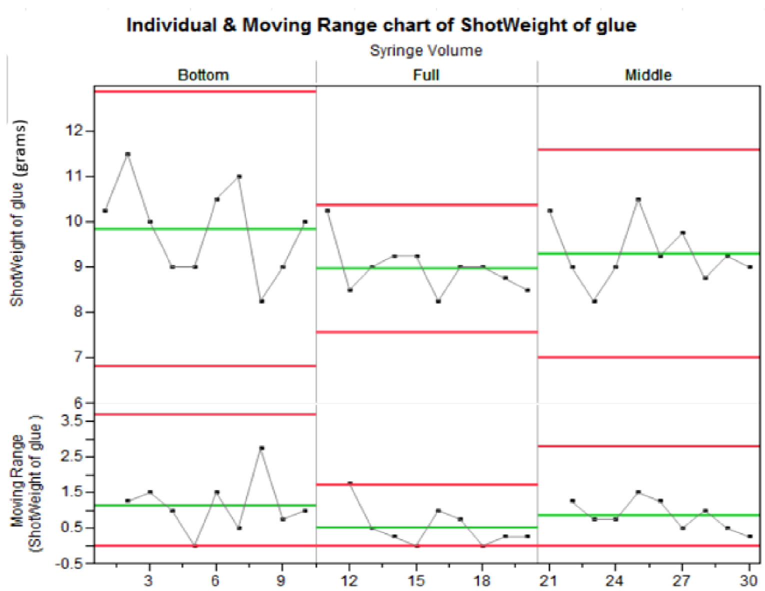
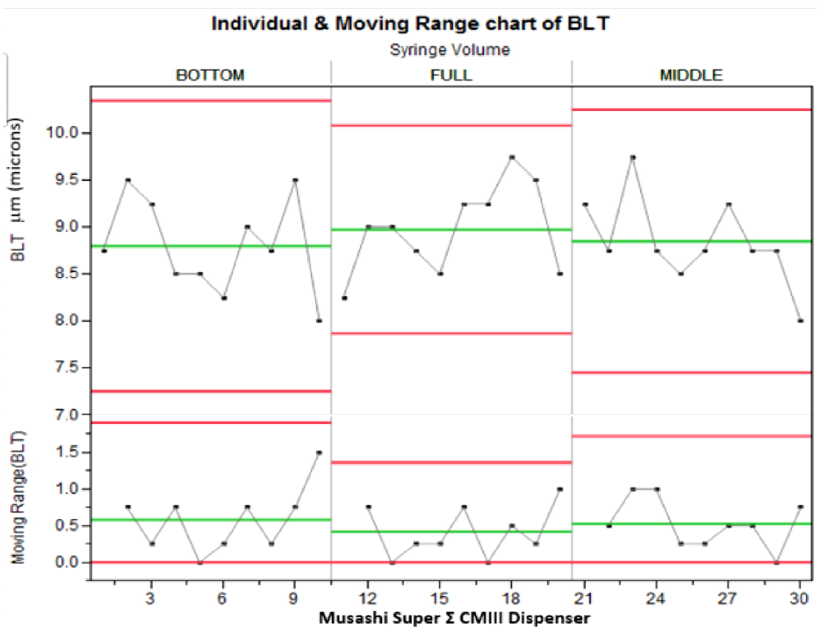


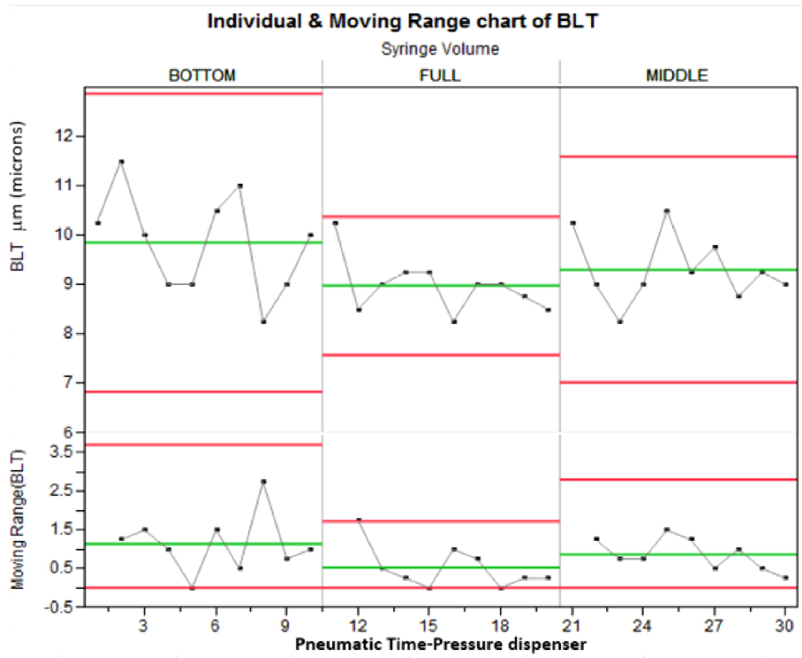
Fig. 6. Individual & moving range chart for pneumatic time-pressure dispenser



BLT Limit Summaries

Points plotted	Syringe Volume	LCL	Avg	UCL	Limits Sigma
Individual	BOTTOM	7.249103	8.8	10.3509	Moving Range
Individual	FULL	7.867216	8.975	10.08278	Moving Range
Individual	MIDDLE	7.446807	8.85	10.25319	Moving Range
Moving Range	BOTTOM	0	0.583333	1.905477	Moving Range
Moving Range	FULL	0	0.416667	1.361055	Moving Range
Moving Range	MIDDLE	0	0.527778	1.724003	Moving Range

Fig. 7. Individual & moving range chart for Musashi super Σ CMIII dispenser



BLT Limit Summaries

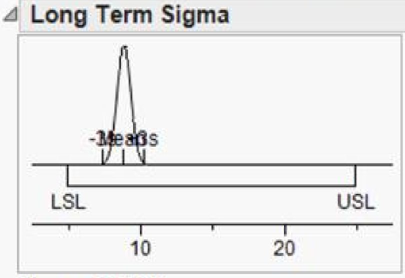
Points plotted	Syringe Volume	LCL	Avg	UCL	Limits Sigma
Individual	BOTTOM	6.822058	9.85	12.87794	Moving Range
Individual	FULL	7.571807	8.975	10.37819	Moving Range
Individual	MIDDLE	7.01058	9.3	11.58942	Moving Range
Moving Range	BOTTOM	0	1.138889	3.720217	Moving Range
Moving Range	FULL	0	0.527778	1.724003	Moving Range
Moving Range	MIDDLE	0	0.861111	2.812847	Moving Range

Fig. 8. Individual & moving range chart for pneumatic time-pressure dispenser

Capability Analysis

Specification	Value	Portion	% Actual
Lower Spec Limit	5	Below LSL	0.0000
Spec Target	.	Above USL	0.0000
Upper Spec Limit	25	Total Outside	0.0000

Long Term Sigma



Sigma = 0.47683

Capability	Index	Lower CI	Upper CI
CP	6.991	5.200	8.778
CPK	2.709	2.002	3.416
CPM	.	.	.
CPL	2.709	2.004	3.411
CPU	11.272	8.382	14.156

Portion	Percent	PPM	Sigma Quality
Below LSL	0.0000	0.0000	9.626
Above USL	0.0000	0.0000	.
Total Outside	0.0000	0.0000	9.626

Fig. 9. Process capability for Musashi super Σ CMIII dispenser

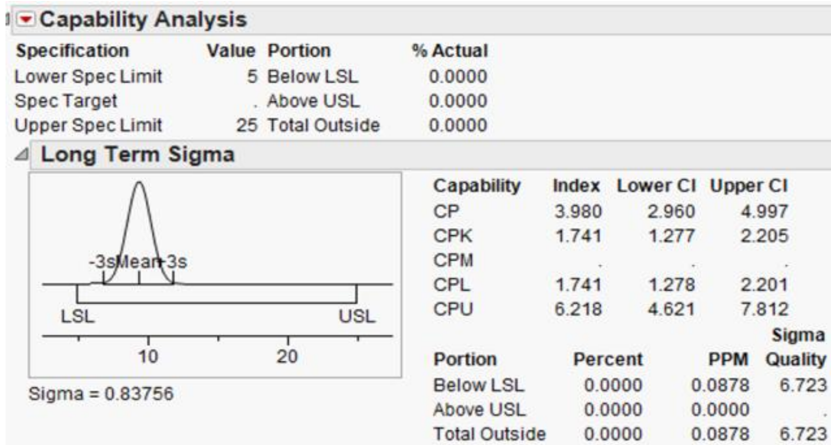


Fig. 10. Process capability for pneumatic time-pressure dispenser

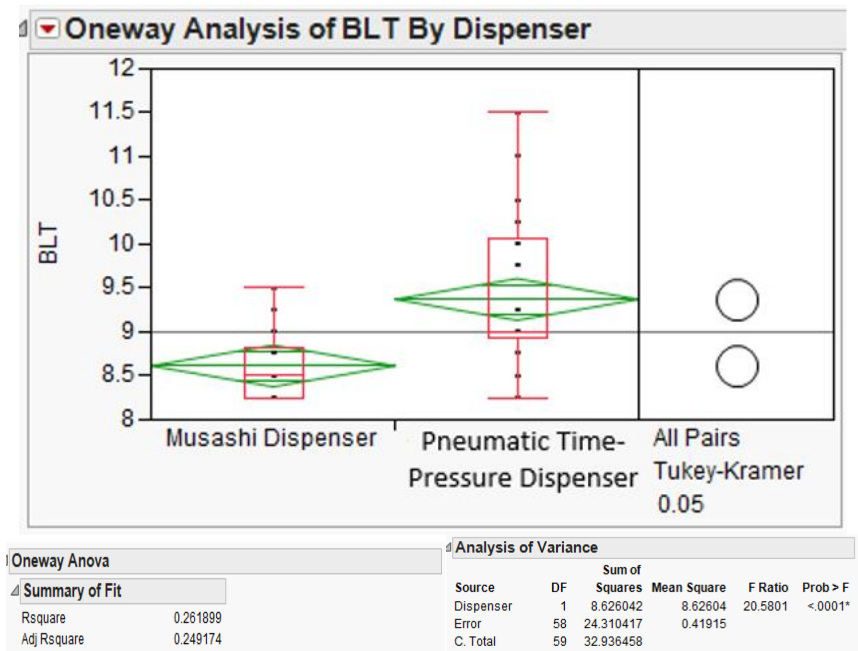


Fig. 11. Two-sample T-test

5. CONCLUSION

The Musashi Super Σ CMIII Dispenser controller offers more options to control the dispensed volume as the remaining material in the syringe reduces, it can be a more suitable tool for glue dispensing. However, for each die size, different parameters must be set to find out these parameters, a test on each existing product/ die size must be accomplished. Moreover, when the dispense parameters are set, the dispense process speed (which is set from the die attach machine) must be kept constant. If the processing speed is varied, the whole exercise must be carried out to find the suitable dispensing parameters of the Musashi controller. This is because the processing speed of the dispenser is not directly linked with the dispensing time set in the Musashi controller unless the Musashi controller is operated in manual mode (automatic correction of volume reduction not available in manual mode).

After the implementation of this change, the glue volume consistency will be more stable. This controller has the option for pressure and vacuum compensation as the remaining fluid in the syringe reduces. Musashi dispenser controller is equipped with empty syringe detection. This can prevent fluctuations in dispensed volume as the remaining glue.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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