Product Application Data Package - QMI529HT

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QMI529HT

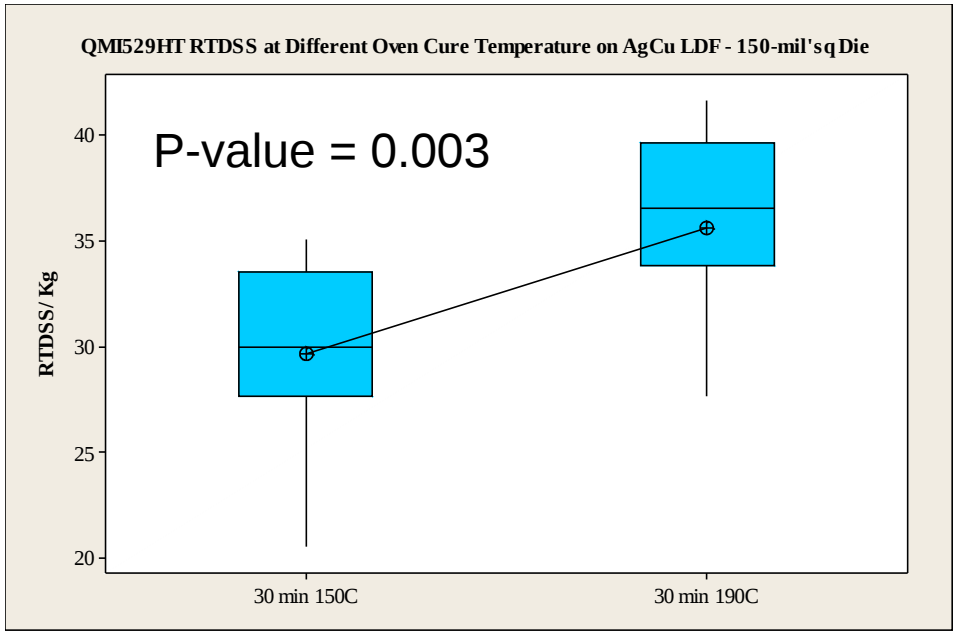
- **QMI529HT is a highly silver filled conductive adhesive designed to provide excellent electrical and thermal conductivity. The material's hydrophobic and high temperature stability characteristics produce void-free bond lines with excellent adhesive strength, enabling adhesion to a wide variety of metals and ceramic surfaces, including copper, silver-plated copper and pre-plated leadframes. Henkel's patented bismaleimide (BMI) formulation also has particularly robust adhesion to NiPdAu leadframes.**

QMI529HT

	SR8	QMI529HT	FS849-TI	2600AT	8491
Filler Type	Ag	Ag	Ag	Ag	Ag
Color	Silver	Silver	Silver	Silver	Silver
Viscosity at 25C	9,400	18500	12,500	8,500	14,000
T.I	5.3	4.8	5.2	6	5
Work life at 25C	24	24	24	24	24
Storage life at 40C	1	1	1	1	1
Cure condition	30 min @ 175C	Snap or Oven	15 min @175C	15 min @ 200C	15 min @ 175C
Volume resistivity,	0.000048	0.00004	0.00002	0.00005	0.00005
Thermal conductivity	7	7	8	8	
Wt loss on cure	4.2	2.5	2.9	9.2	2.7
Tg by penetration	36.2	3.3	205	84	153
CTE					
below Tg	41	53	44	30	57
above Tg	100	156	154	121	179
Modulus @ 25C	7.9 Gpa	3.3 Gpa	7.8 Gpa	3.6	7.2

Oven Cure Study

- **The adhesion was compared for QMI529HT cured using different box oven temperatures.**
- **Data was obtained at both RT shear interval: -**



Two-Sample T-Test and CI: 30 min 150C, 30 min 190C

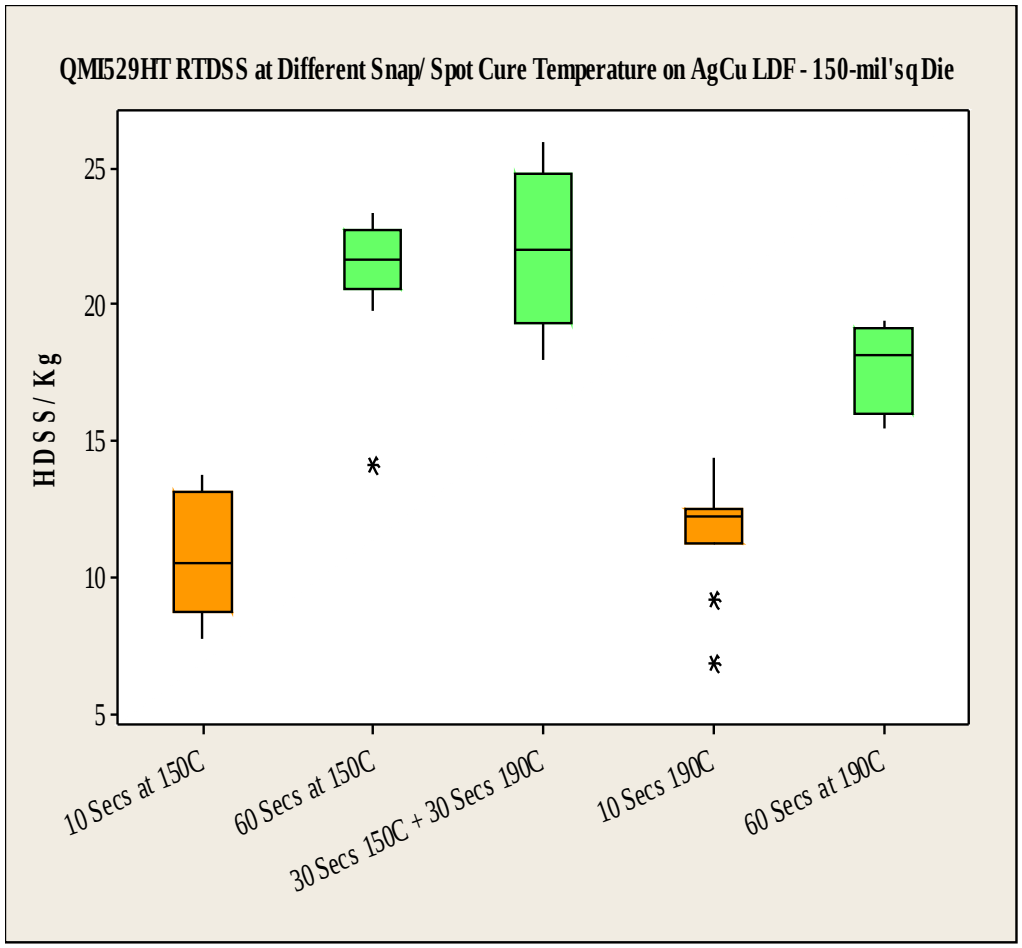
Two-sample T for 30 min 150C vs 30 min 190C

	N	Mean	StDev	SE Mean
30 min 150C	12	29.68	4.43	1.3
30 min 190C	11	35.62	4.14	1.2

Difference = mu (30 min 150C) - mu (30 min 190C)
Estimate for difference: -5.93
95% CI for difference: (-9.66, -2.21)
T-Test of difference = 0 (vs not =): T-Value = -3.32 P-Value = 0.003 DF = 20

P-value <0.05 indicates that curing a190℃ gives a statistically higher adhesion strength than 150 ℃.

QMI529HT
Snap/ Spot Cure Study

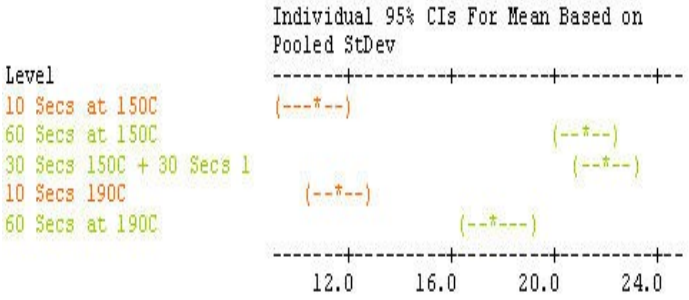


One-way ANOVA: 10 Secs at 1, 60 Secs at 1, 30 Secs 150C, 10 Secs 190C, ...

Source	DF	SS	MS	F	P
Factor	4	1252.42	313.10	62.06	0.000
Error	53	267.38	5.04		
Total	57	1519.80			

S = 2.246 R-Sq = 82.41% R-Sq(adj) = 81.08%

Level	N	Mean	StDev
10 Secs at 150C	10	10.760	2.152
60 Secs at 150C	12	21.167	2.504
30 Secs 150C + 30 Secs 1	12	22.050	2.906
10 Secs 190C	12	11.658	1.926
60 Secs at 190C	12	17.767	1.448



Pooled StDev = 2.246

Snap cure statistically higher adhesion than Spot cure!

Open Time Study for QMI529HT.

Background

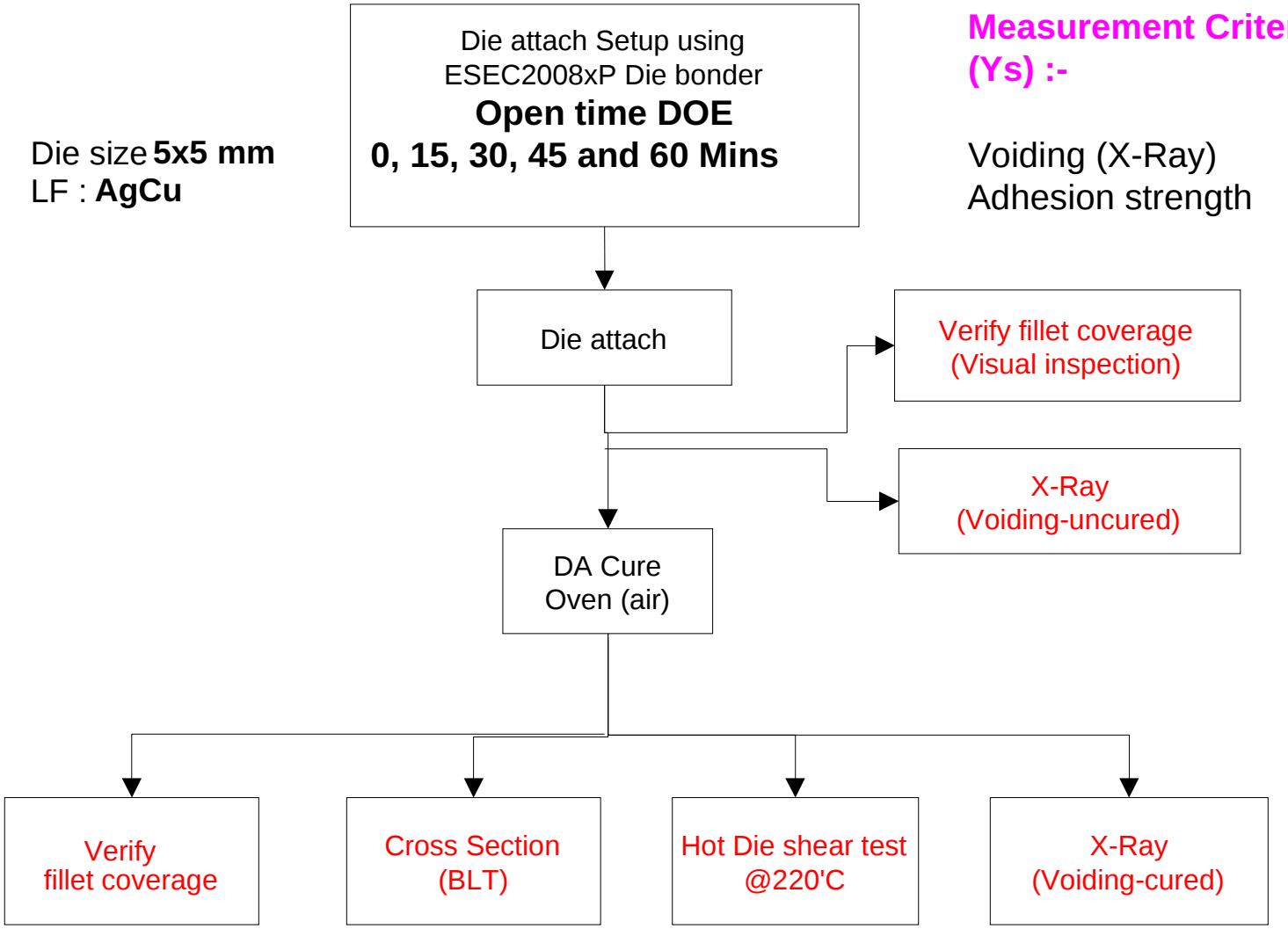
- **Open time is the time that a die attach adhesive is left after dispense before die placement.**

- **Some adhesives lose low molecular weight components from the bulk when exposed to the atmosphere at ambient conditions. This loss of low molecular weight material can result in reduced wet out at die attach, impact final BLT, reduce fillet formation and cause die attach voiding. Therefore open time is a critical die attach adhesive property.**

- **QMI529HT is a volume product used in packages requiring excellent electrical and thermal performance. It is necessary to quantify the performance of this product in respect of open time.**

Experimental Design

Die size **5x5 mm**
LF : **AgCu**



Measurement Criteria (Ys) :-

Voiding (X-Ray)
Adhesion strength

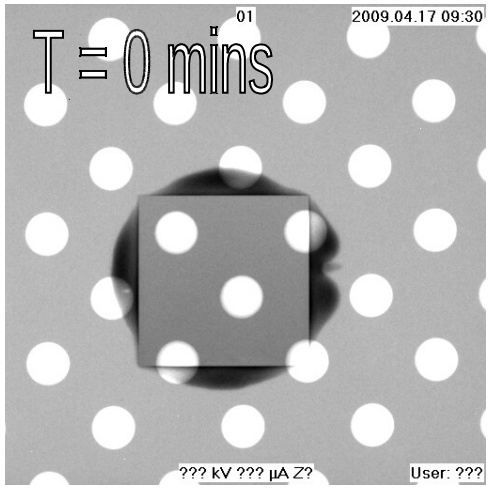
Experimental

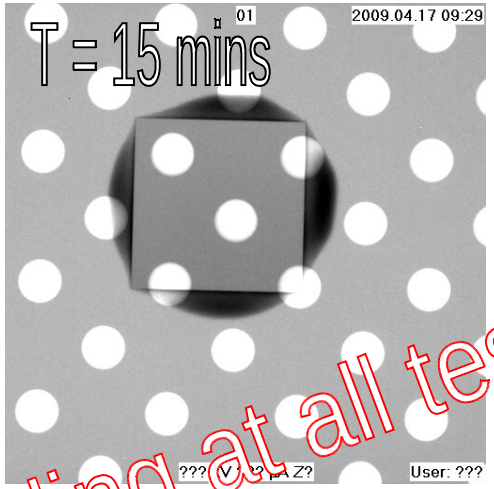
- **The following set up and equipment was used for the test build and subsequent analysis.**
  - **Die size :** **2 x 2, 5 x 5 & 8 x 8-mm**
  - **DA Machine :** **ESEC 2008xP.**
  - **Dispense method :** **Writing with Pneumatic pump.**
  - **Die Attach Force:** **Varied (50g, 200g & 250g)**
  - **Die Attach Bond Time:** **Varied 200, 500, & 1500 mS.**
  - **Fillet height :** **75%**
  - **Leadframe :** **In-house AgCu**
  - **Void X-Ray :** **Phoenix (parameters : 140 kV & 30uA)**
  - **Mat'l :** **QMI529HT**
  - **Open time :** **0, 15, 30, 45, and 60 mins.**

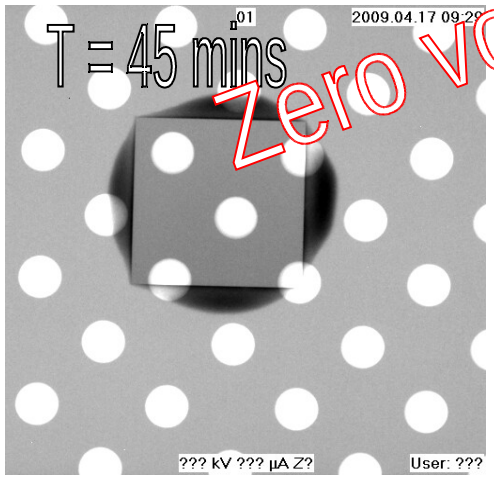
Results.

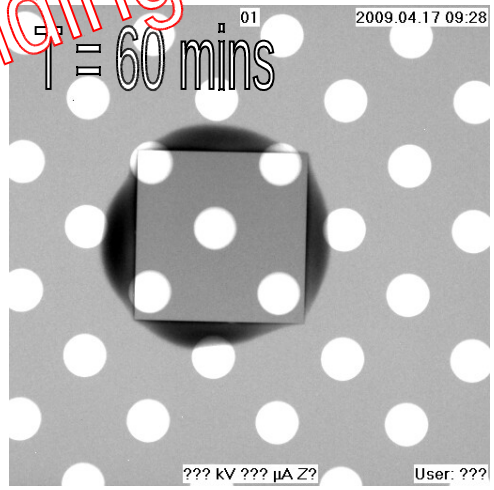
X-ray Inspection – 2 x 2-mm Die Size

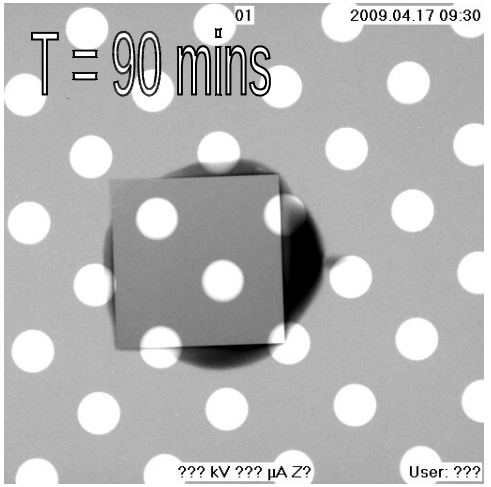
- **The bond lines were inspected using x-ray: -**









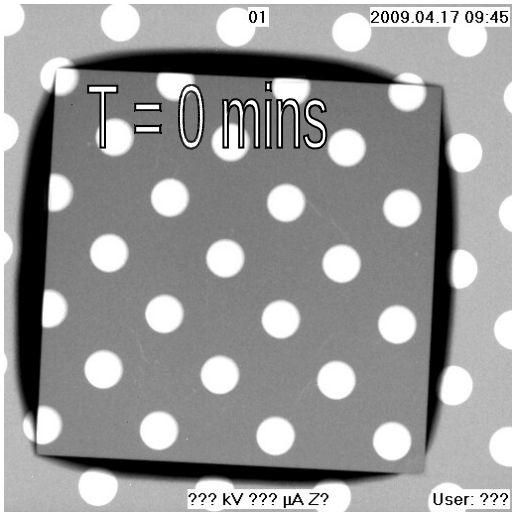


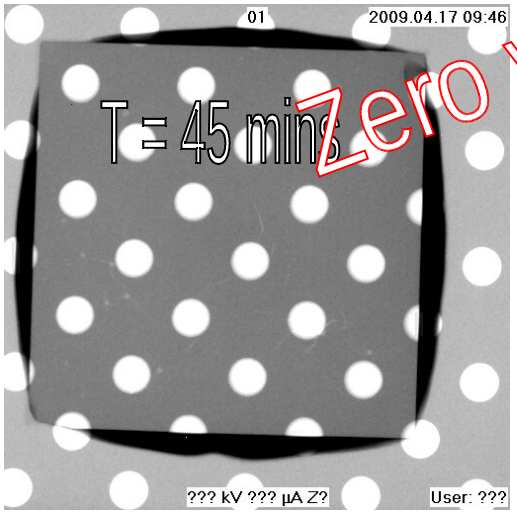
Zero voiding at all test intervals!

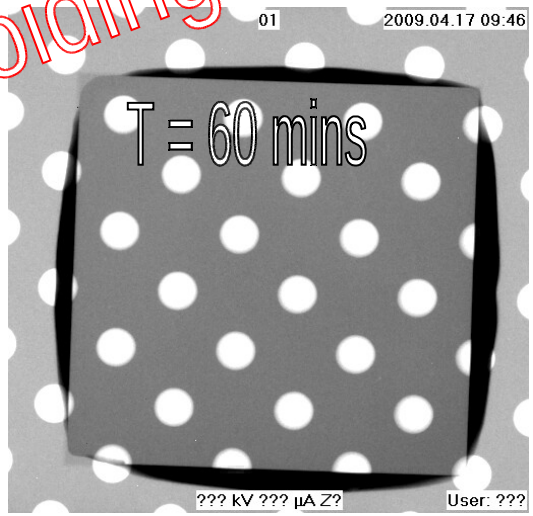
Results.

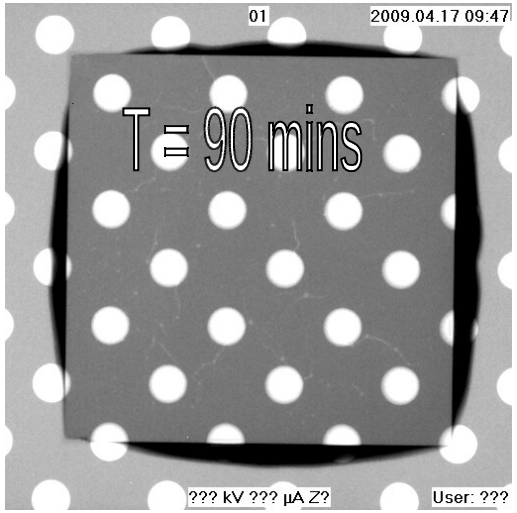
X-ray Inspection – 5 x 5-mm Die Size

- **The bond lines were inspected using x-ray: -**







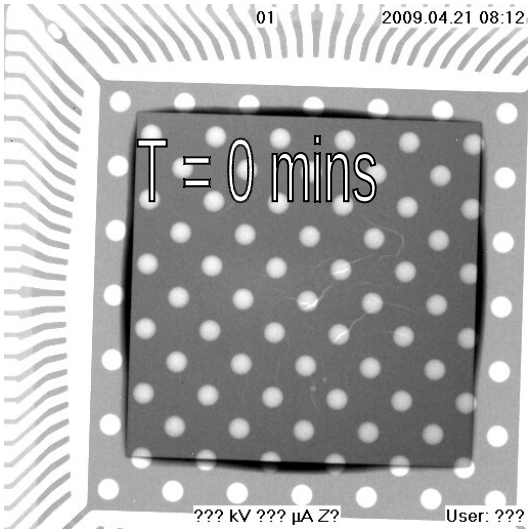


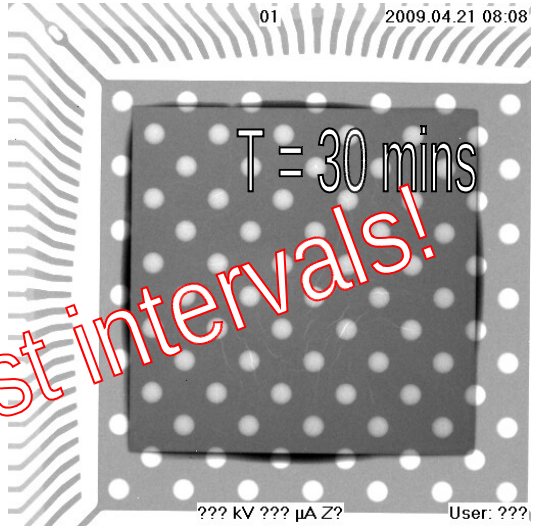
Zero voiding at all test intervals!

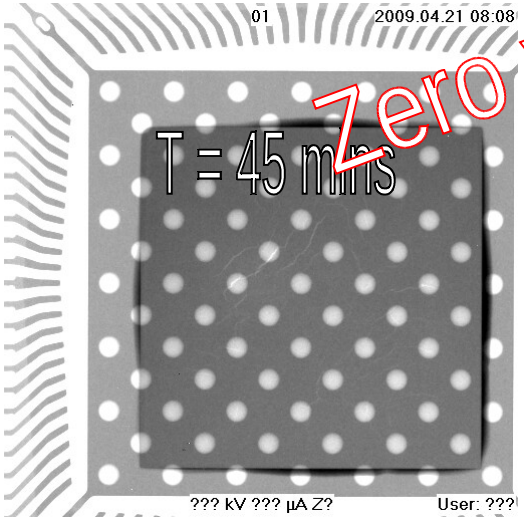
Results.

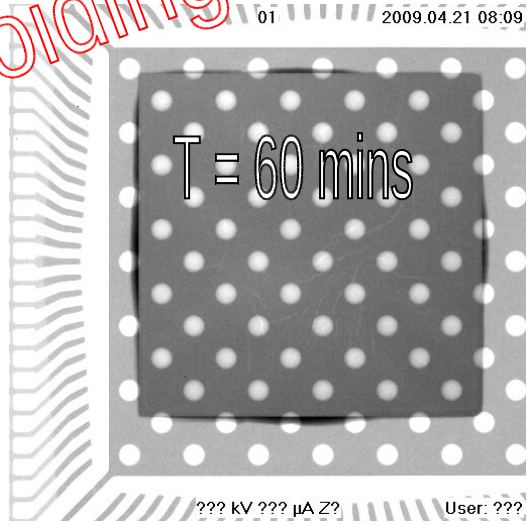
X-ray Inspection – 8 x 8-mm Die Size

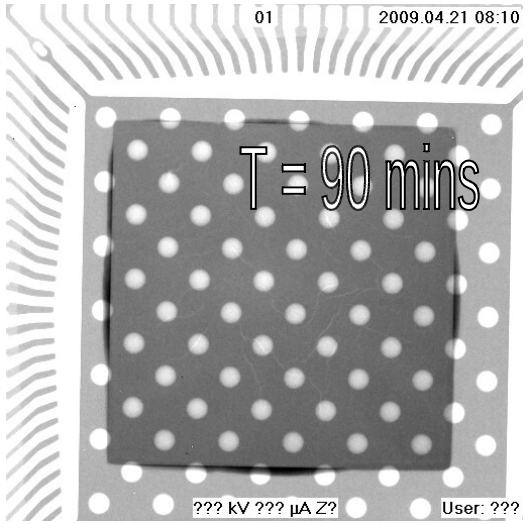
- **The bond lines were inspected using x-ray: -**





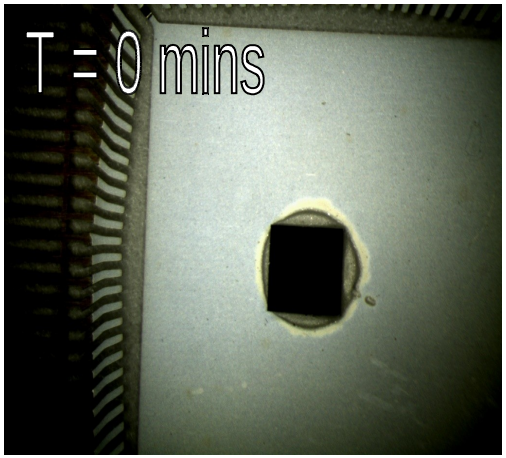


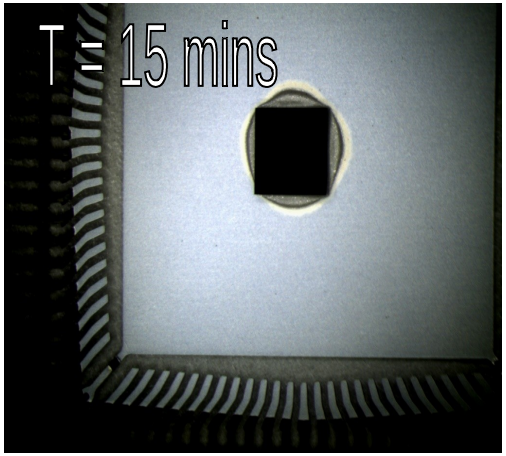


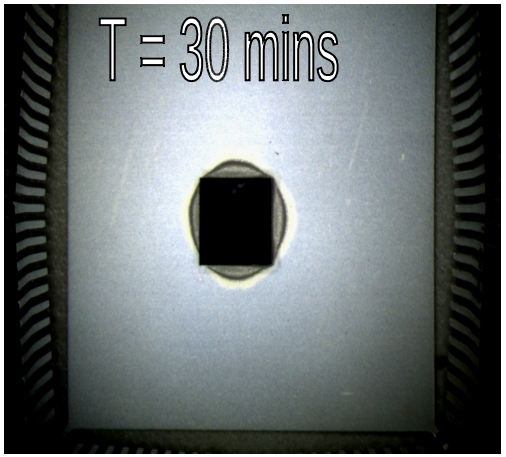


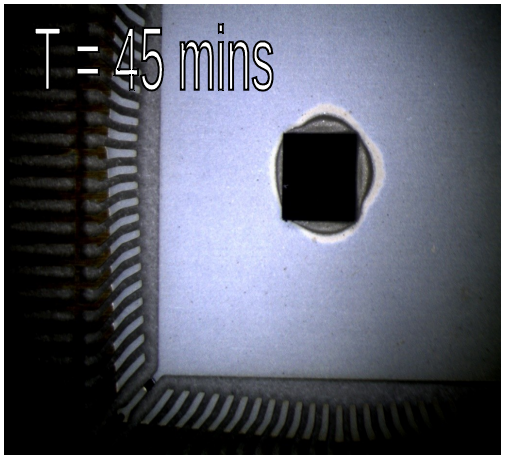
Zero voiding at all test intervals!

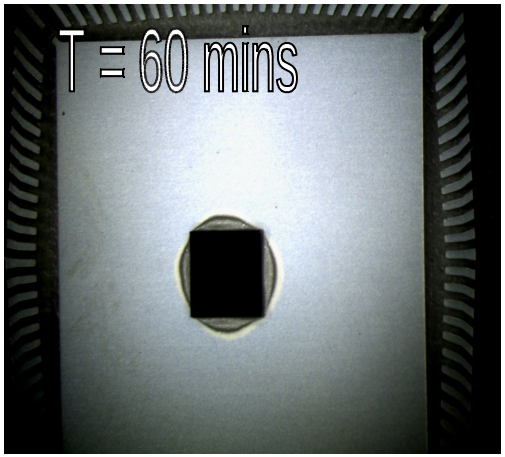
Results.
Fillet Inspection – 2 x 2-mm Die Size.

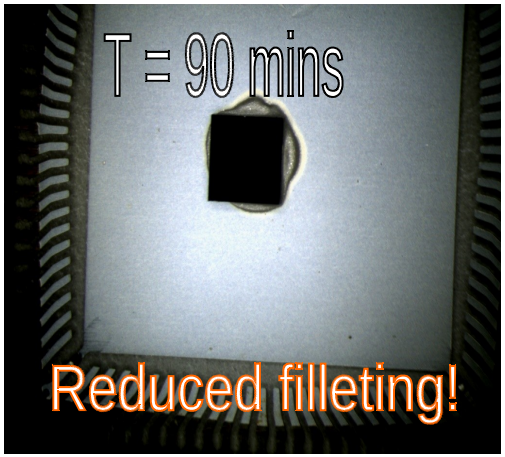




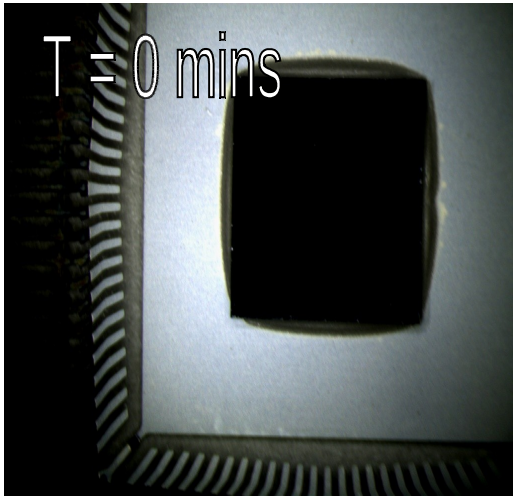


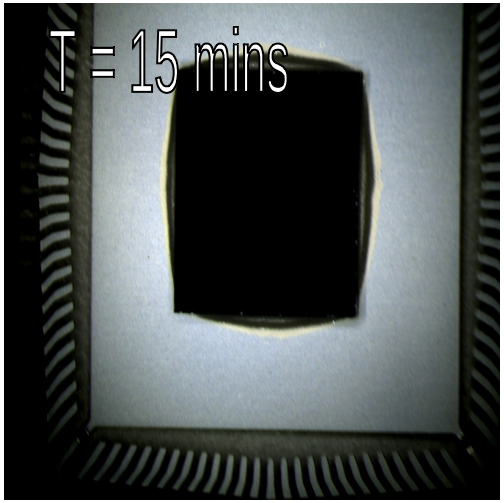


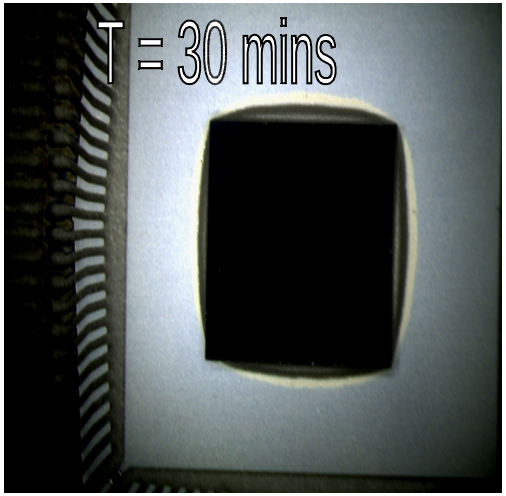


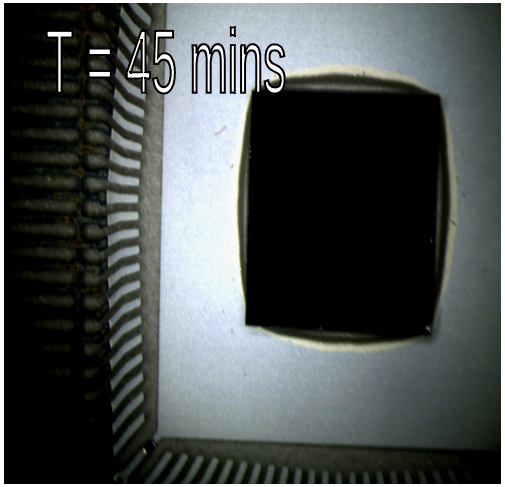


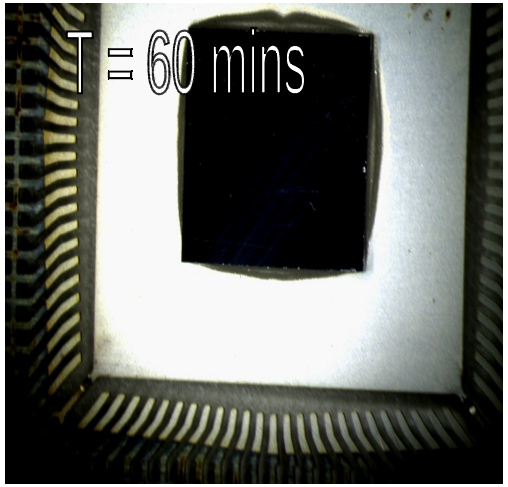
Results.
Fillet Inspection – 5 x 5-mm Die Size.

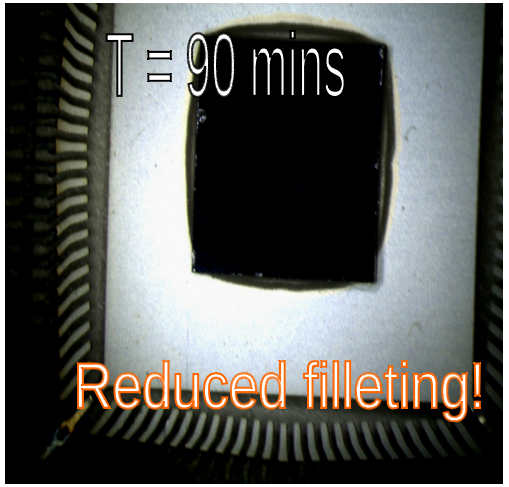




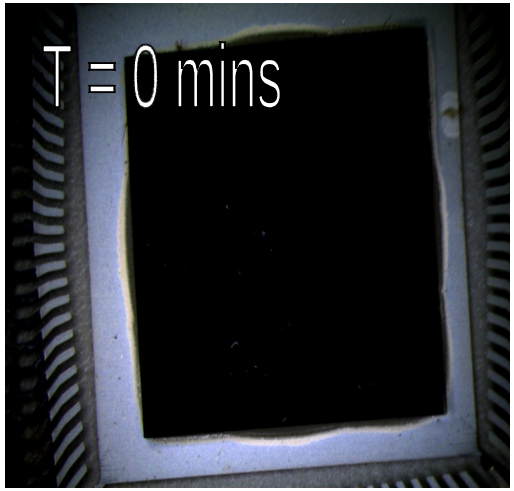


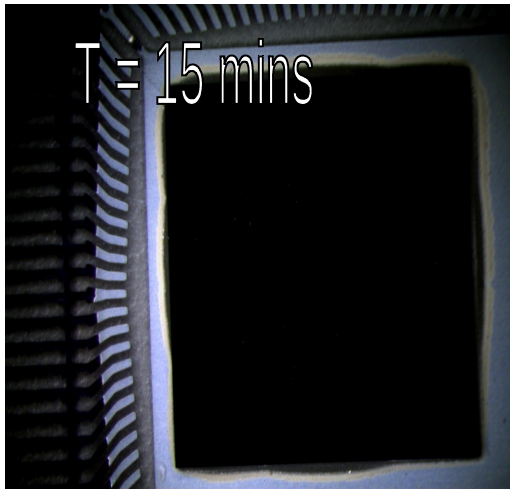


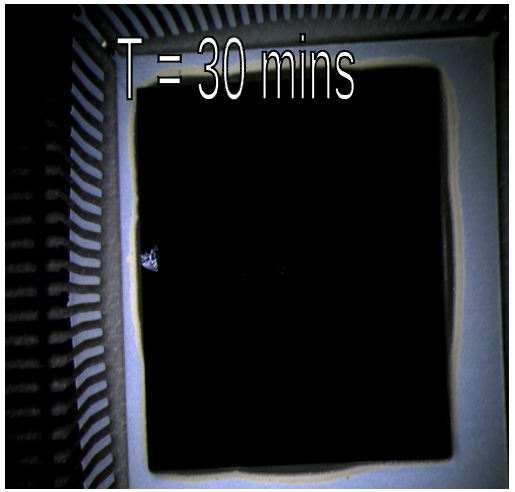


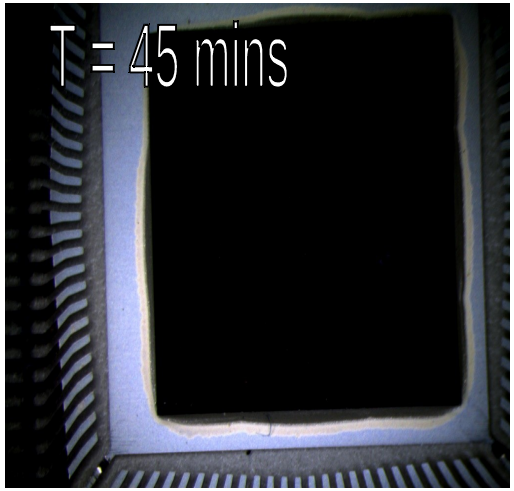


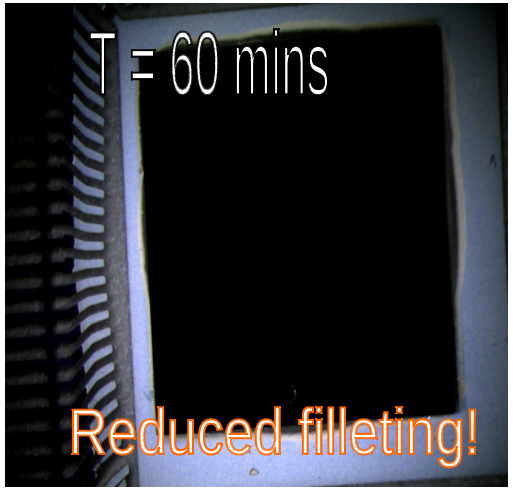
Results.
Fillet Inspection – 8 x 8-mm Die Size.

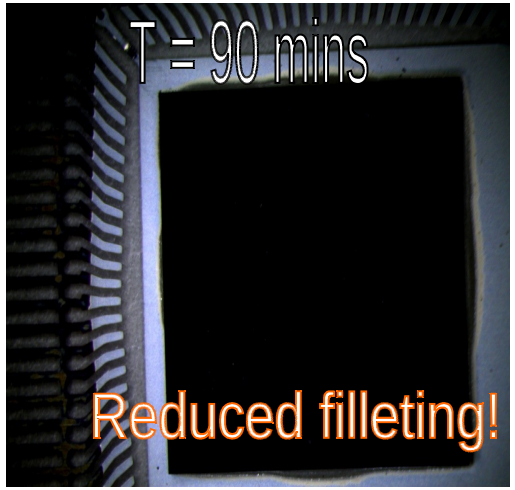












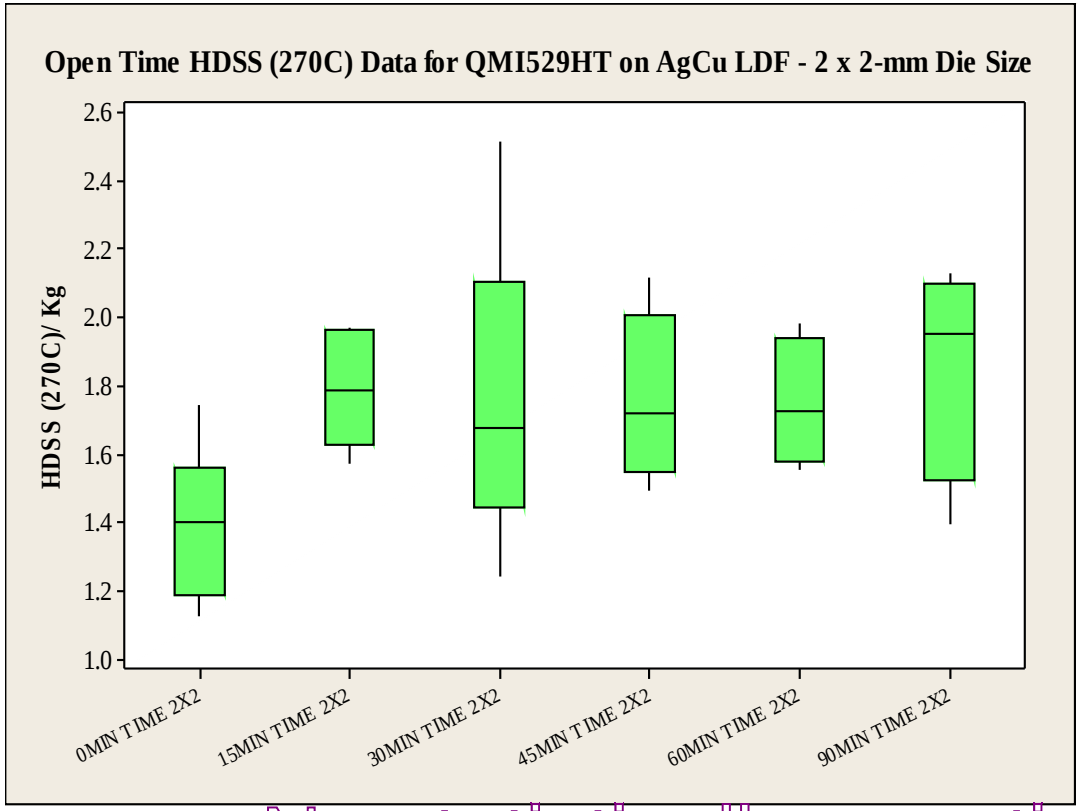
Adhesion Data

- **The HDSS (270℃) was recorded on AgCu LDF for each die size. The data can be viewed in statistical and graphical format.**
- **Basic Statistics**

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
0MIN TIME 2X2	8	1.3926	0.2189	0.0479	1.1280	1.7470
15MIN TIME 2X2	8	1.7956	0.1627	0.0265	1.5750	1.9730
30MIN TIME 2X2	8	1.764	0.417	0.174	1.239	2.515
45MIN TIME 2X2	8	1.7656	0.2327	0.0542	1.4960	2.1180
60MIN TIME 2X2	8	1.7540	0.1735	0.0301	1.5550	1.9810
90MIN TIME 2X2	8	1.833	0.299	0.090	1.395	2.133
0MIN TIME 5X5	8	4.078	0.671	0.451	2.815	5.224
15MIN TIME 5X5	8	4.282	1.718	2.951	2.839	8.306
30MIN TIME 5X5	8	4.360	1.149	1.320	3.212	6.911
45MIN TIME 5X5	8	5.410	1.985	3.942	2.752	9.351
60MIN TIME5X5	8	5.65	3.05	9.29	2.82	9.91
90MIN TIME 5X5	8	5.49	3.09	9.54	2.92	9.85
0MIN TIME 8 X 8	8	29.89	5.10	26.01	21.27	34.94
15MIN TIME 8 X 8	8	25.14	3.12	9.76	22.05	30.43
30MIN TIME 8 X 8	8	27.55	3.83	14.66	23.26	33.52
45MIN TIME 8 X 8	8	27.710	2.054	4.218	24.848	30.910
60MIN TIME 8X8	8	27.39	3.56	12.66	23.87	33.66
90MIN TIME 8 X 8	8	29.281	0.817	0.667	28.106	30.498

Adhesion Data

- **The below graphs and ANOVA comparison details the adhesion strength at the different time intervals for the 2 x 2-mm die size: -**



One-way ANOVA: 0MIN TIME 2X, 15MIN TIME 2, 30MIN TIME 2, 45MIN TIME 2, ...

Source	DF	SS	MS	F	P
Factor	5	1.0462	0.2092	2.97	0.022
Error	42	2.9550	0.0704		
Total	47	4.0011			

S = 0.2652 R-Sq = 26.15% R-Sq(adj) = 17.35%

Level	N	Mean	StDev
0MIN TIME 2X2	8	1.3926	0.2189
15MIN TIME 2X2	8	1.7956	0.1627
30MIN TIME 2X2	8	1.7640	0.4171
45MIN TIME 2X2	8	1.7656	0.2327
60MIN TIME 2X2	8	1.7540	0.1735
90MIN TIME 2X2	8	1.8329	0.2992

Individual 95% CIs For Mean Based on Pooled StDev

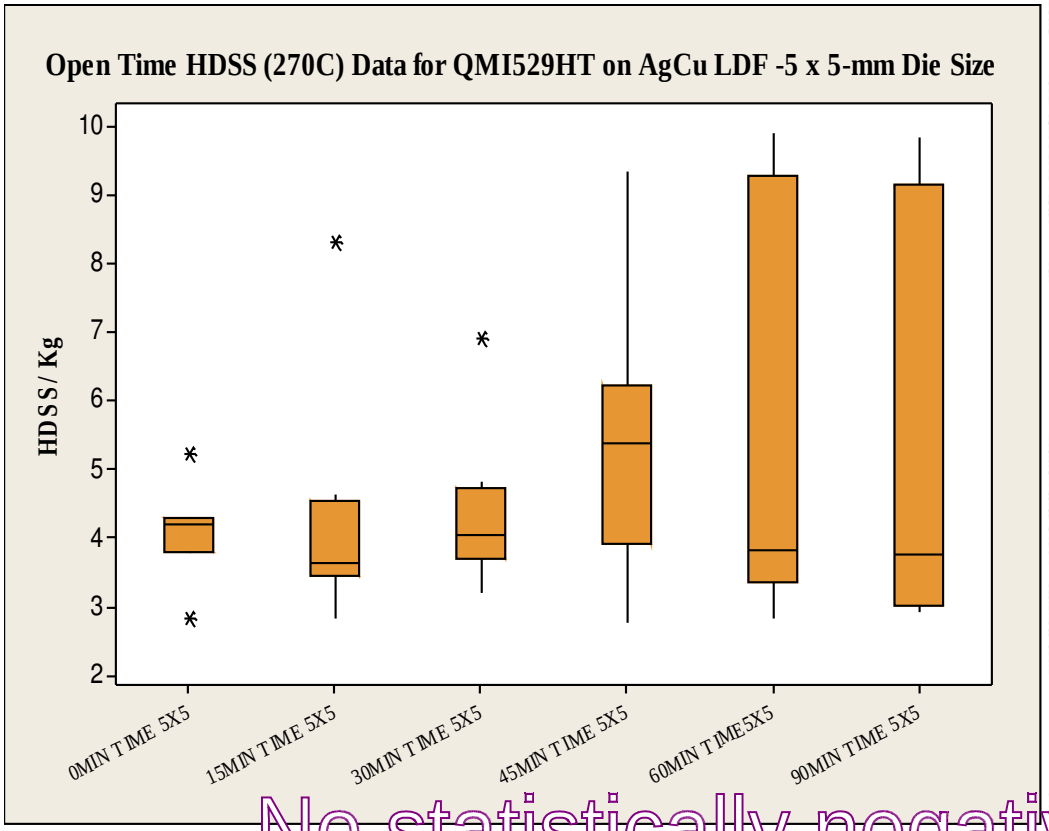
1.25 1.50 1.75 2.00

Pooled StDev = 0.2652

No statistically negative effect of adhesion strength v open time

Adhesion Data

- **The below graphs and ANOVA comparison details the adhesion strength at the different time intervals for the 5 x 5-mm die size: -**



One-way ANOVA: 0MIN TIME 5X, 15MIN TIME 5, 30MIN TIME 5, 45MIN TIME 5, ...

Source	DF	SS	MS	F	P
Factor	5	20.19	4.04	0.88	0.502
Error	42	192.42	4.58		
Total	47	212.61			

S = 2.140 R-Sq = 9.50% R-Sq(adj) = 0.00%

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
0MIN TIME 5X5	8	4.078	0.671	(----------*----------)
15MIN TIME 5X5	8	4.282	1.718	(----------*----------)
30MIN TIME 5X5	8	4.360	1.149	(----------*----------)
45MIN TIME 5X5	8	5.410	1.985	(----------*----------)
60MIN TIME5X5	8	5.653	3.048	(----------*----------)
90MIN TIME 5X5	8	5.492	3.088	(----------*----------)

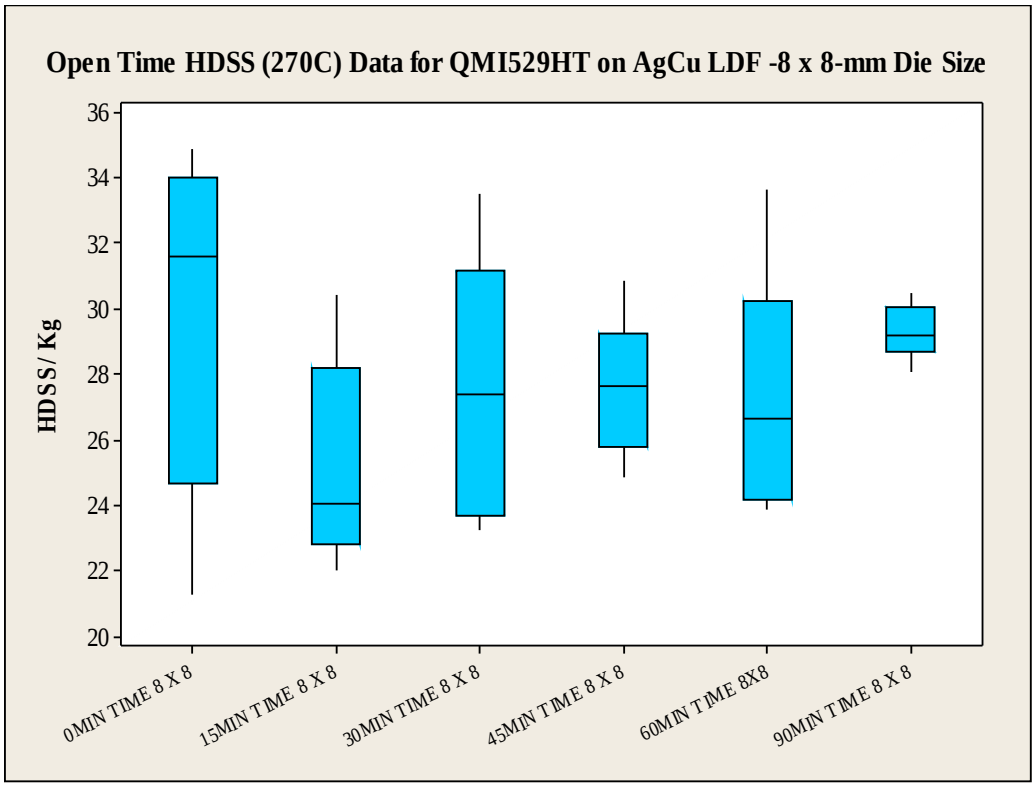
3.6 4.8 6.0 7.2

Pooled StDev = 2.140

No statistically negative effect of adhesion strength v open time

Adhesion Data

- **The below graphs and ANOVA comparison details the adhesion strength at the different time intervals for the 5 x 5-mm die size: -**



One-way ANOVA: 0MIN TIME 8 , 15MIN TIME 8, 30MIN TIME 8, 45MIN TIME 8, ...

Source	DF	SS	MS	F	P
Factor	5	110.8	22.2	1.96	0.105
Error	42	475.8	11.3		
Total	47	586.7			

S = 3.366 R-Sq = 18.89% R-Sq(adj) = 9.24%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev
0MIN TIME 8 X 8	8	29.886	5.100
15MIN TIME 8 X 8	8	25.140	3.124
30MIN TIME 8 X 8	8	27.550	3.829
45MIN TIME 8 X 8	8	27.710	2.054
60MIN TIME 8X8	8	27.388	3.559
90MIN TIME 8 X 8	8	29.281	0.817

25.0 27.5 30.0 32.5

Pooled StDev = 3.366

No statistically negative effect of adhesion strength v open time

Conclusions

- No increase in bond line voiding as a function of adhesive open time.
- When the open time exceeds one hour it does appear that there can be some difference in the filleting behaviour of the product.
- The adhesion of QMI529HT remains unaffected after extended open times.
- Recommendation
  - QMI529HT is not sensitive in respect of open time periods up to 1 hour. Beyond 1 hour it may be possible to observe differences in die filleting, although adhesion remains unaffected. QMI529HT can therefore be considered robust in respect of open time.

Stage Time Evaluation for QMI529HT

Background

- Stage time is the time that an assembled die attach joint is left at ambient temperature prior to the cure.

- Some adhesives lose low molecular weight components from the bulk when exposed to the atmosphere at ambient conditions. This loss of low molecular weight material can result in reduced wet out at die attach, impact final BLT, reduce fillet formation and cause die attach voiding. Therefore stage time is a critical die attach adhesive property.

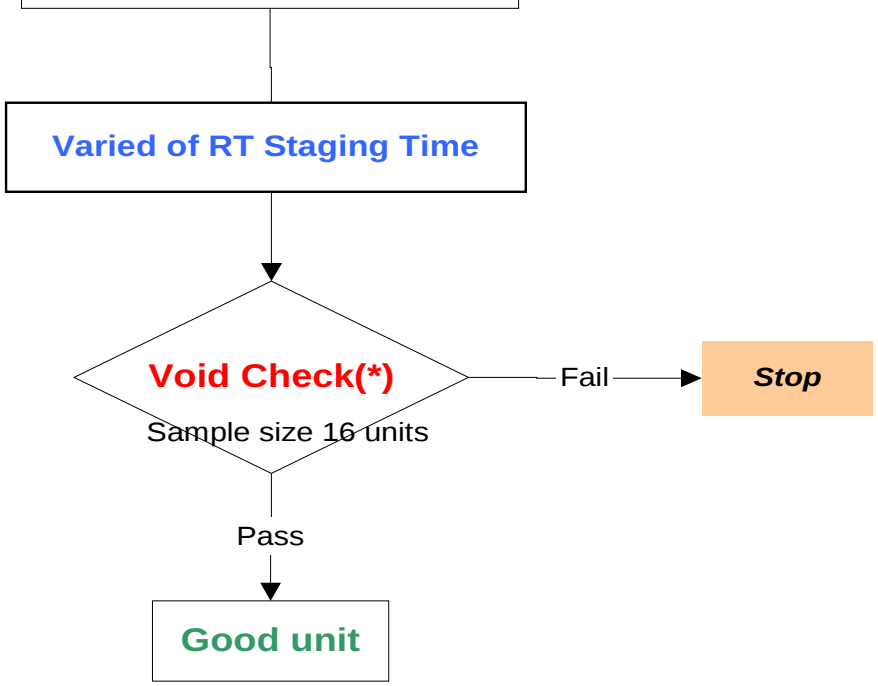
- QMI529HT is a volume product used in packages requiring excellent electrical and thermal performance. It is necessary to quantify the performance of this product in respect of stage time.

Experimental Design

Material :-
QMI529HT

Die Attach (ESEC2008)
With different BLT (dry)
Thin ad thick BL
(By Z-height measurement)

Measurement Criteria (Ys) :-
X-Ray (Voiding)
HDSS
Fillet Inspection (Bleed).



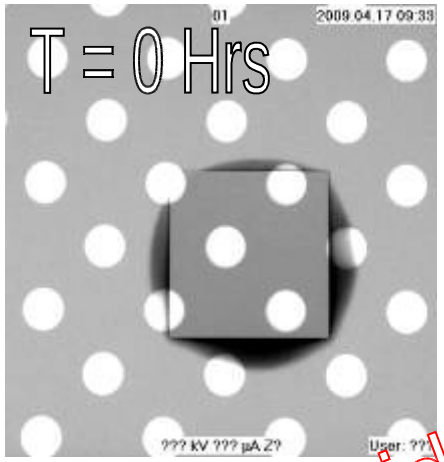
Experimental

- **The following set up and equipment was used for the test build and subsequent analysis.**
  - **Die size :** **2 x 2, 5 x 5 & 8 x 8-mm**
  - **DA Machine :** **ESEC 2008xP.**
  - **Dispense method :** **Writing with Pneumatic pump.**
  - **Die Attach Force:** **Varied (50g, 200g & 250g)**
  - **Die Attach Bond Time:** **Varied 200, 500, & 1500 mS.**
  - **Fillet height :** **75%**
  - **Leadframe :** **In-house AgCu**
  - **Void X-Ray :** **Phoenix (parameters : 140 kV & 30uA)**
  - **Mat'l :** **QMI529HT**
  - **Stage Time :** **0, 2, 4, 6, and 8 Hours.**

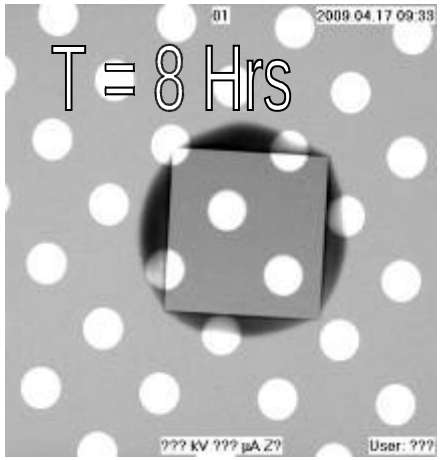
Results.

X-ray Inspection – 2 x 2-mm Die Size

- **The bond lines were inspected using x-ray: -**



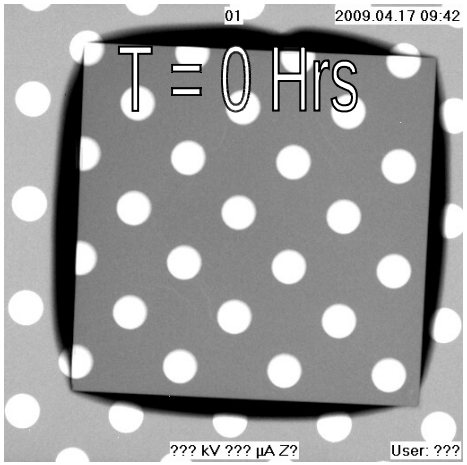
Zero voiding at all test intervals!

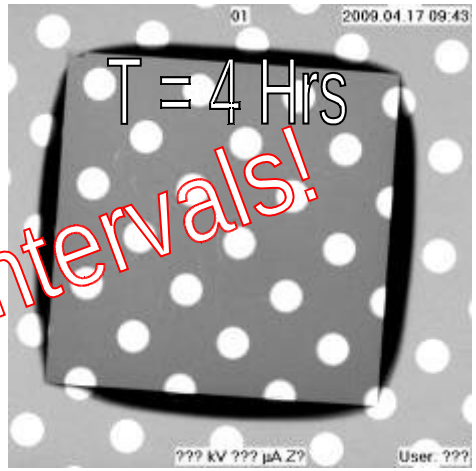


Results.

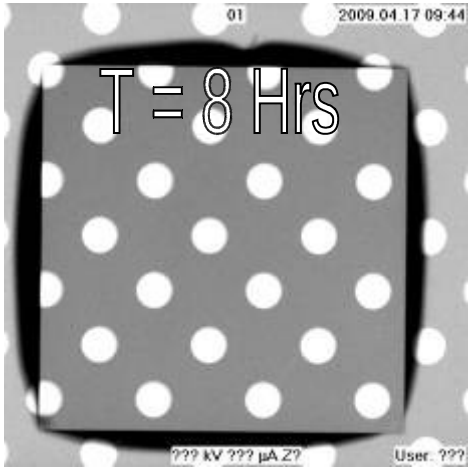
X-ray Inspection – 5 x 5-mm Die Size

- **The bond lines were inspected using x-ray: -**





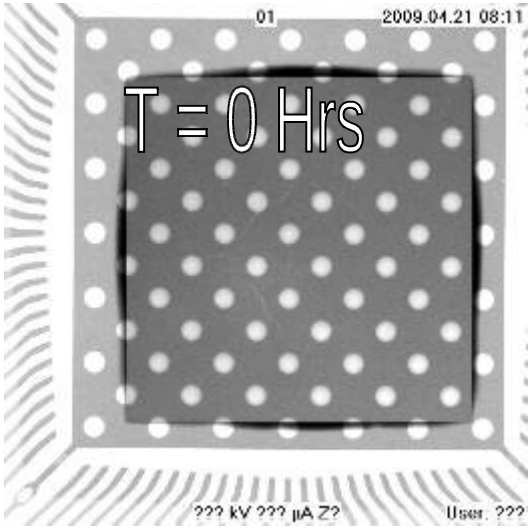
Zero voiding at all test intervals!

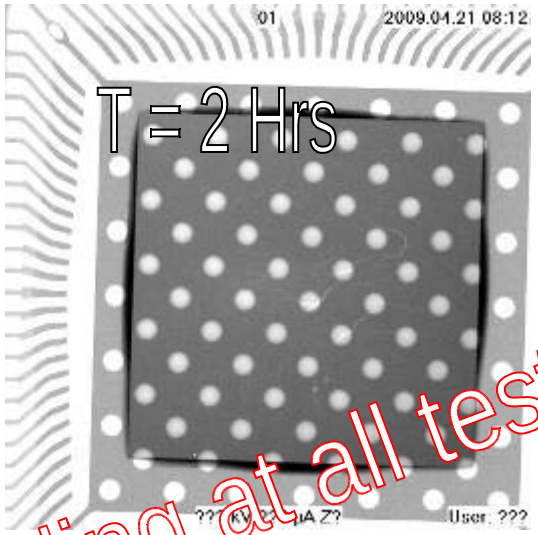


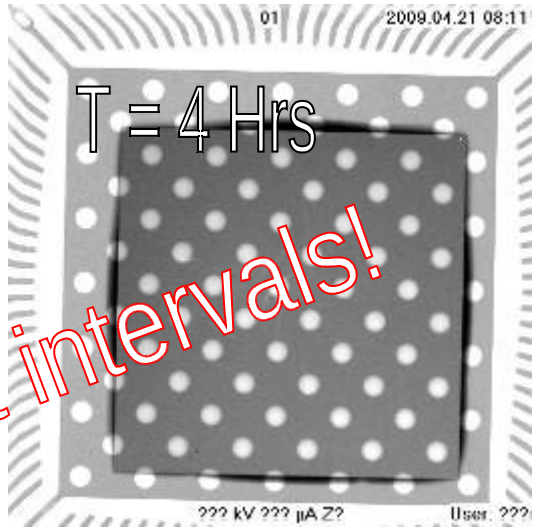
Results.

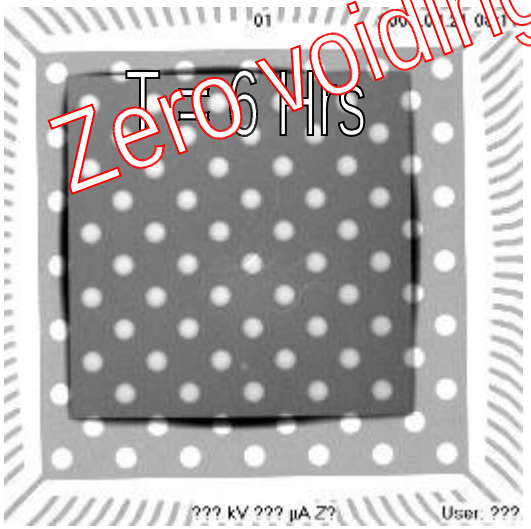
X-ray Inspection – 8 x 8-mm Die Size

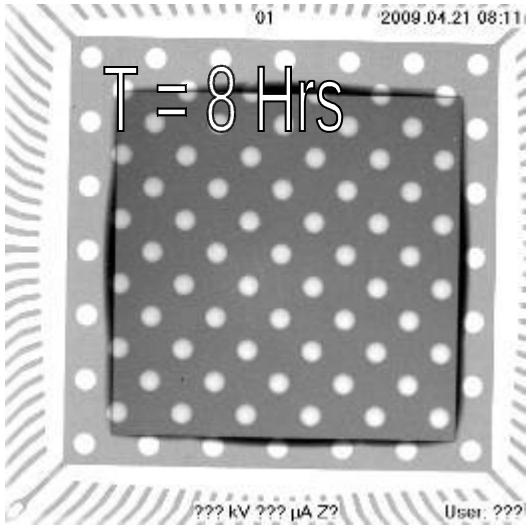
- **The bond lines were inspected using x-ray: -**





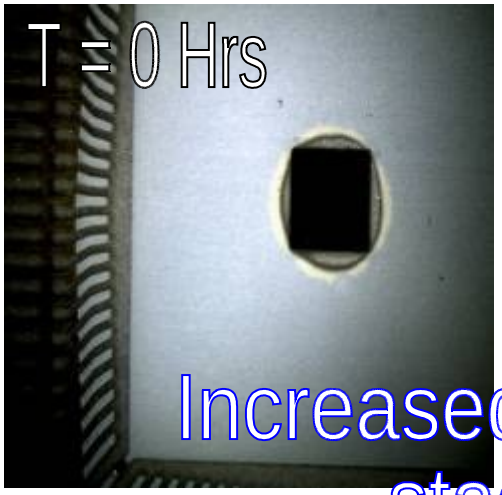


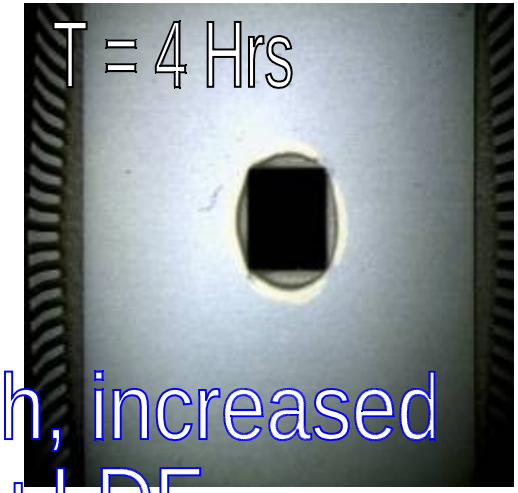




Zero voiding at all test intervals!

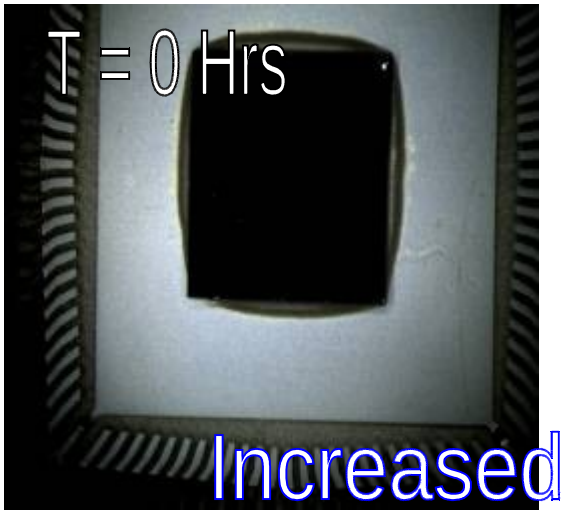
Results.
Fillet Inspection – 2 x 2-mm Die Size.

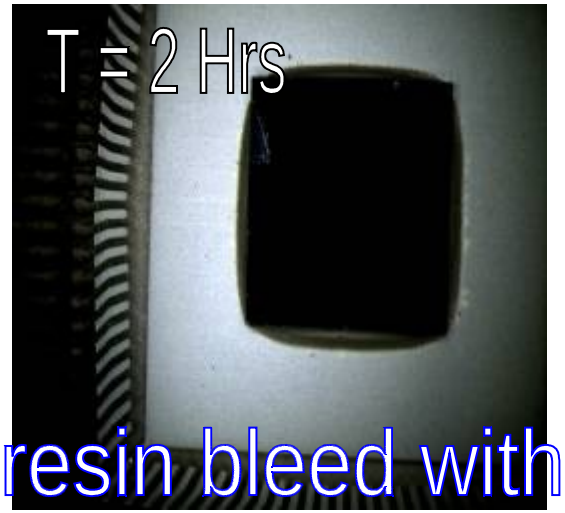


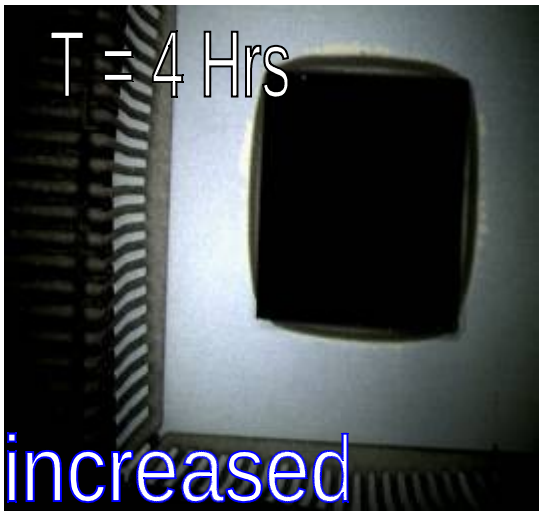


Increased resin bleed with, increased stage time on AgCu LDF.

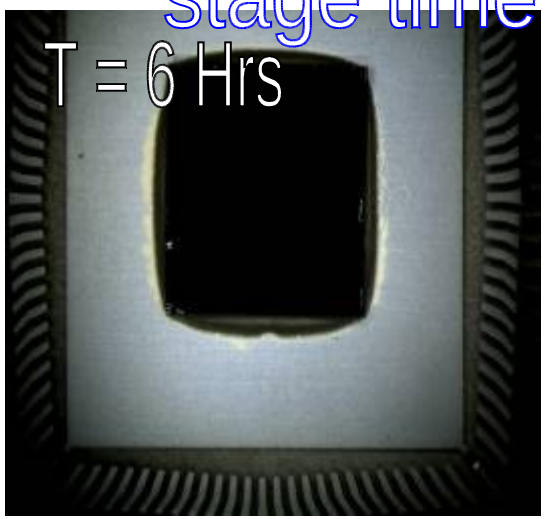
Results.
Fillet Inspection – 5 x 5-mm Die Size



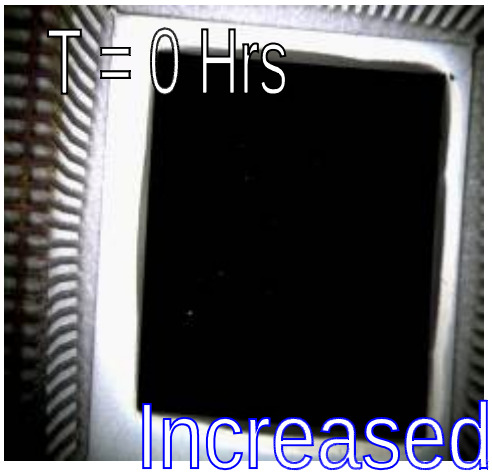


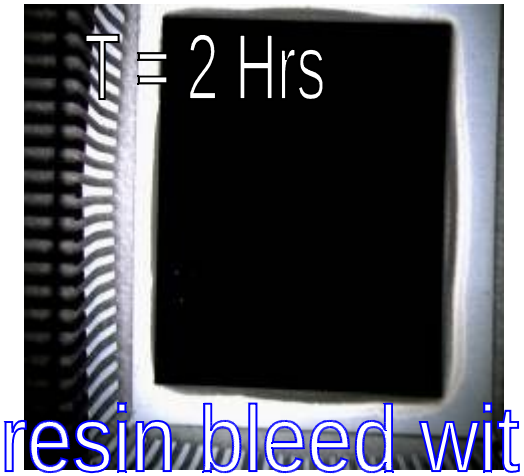


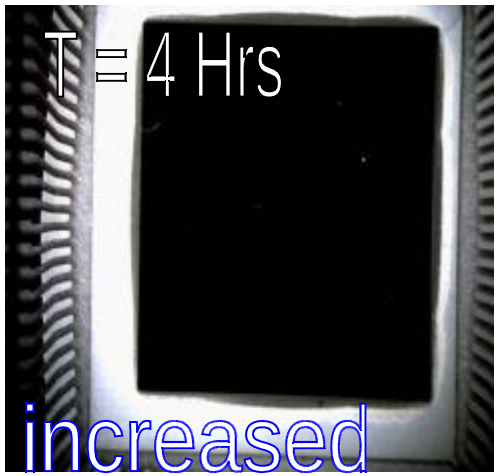
Increased resin bleed with, increased stage time on AgCu LDF.



Results.
Fillet Inspection – 8 x 8-mm Die Size







Increased resin bleed with, increased stage time on AgCu LDF.

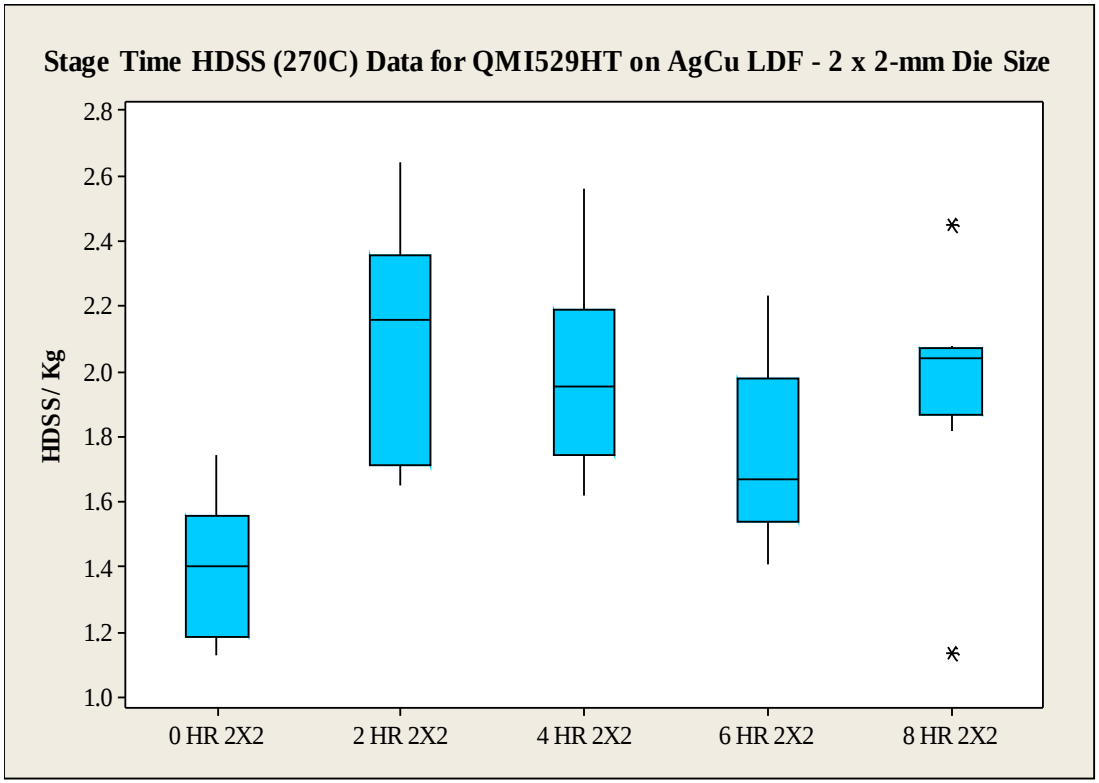
Adhesion Data

- **The HDSS (270℃) was recorded on AgCu LDF for each die size. The data can be viewed in statistical and graphical format.**
- **Basic Statistics**

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
0 HR 2X2	8	1.3926	0.2189	0.0479	1.1280	1.7470
2 HR 2X2	8	2.099	0.365	0.133	1.653	2.642
4 HR 2X2	8	1.987	0.308	0.095	1.622	2.561
6 HR 2X2	8	1.7436	0.2734	0.0748	1.4130	2.2330
8 HR 2X2	8	1.955	0.375	0.141	1.135	2.454
0 HR 5X5	8	4.078	0.671	0.451	2.815	5.224
2 HR 5X5	8	3.776	0.994	0.988	2.590	5.958
4 HR 5X5	8	3.990	0.830	0.689	3.124	5.093
6 HR 5X5	8	4.395	1.992	3.967	3.228	9.137
8 HR 5X5	8	6.00	3.40	11.57	3.66	14.18
0 HR 8X8	8	29.89	5.10	26.01	21.27	34.94
2 HR 8X8	8	25.83	5.85	34.20	18.60	34.16
4 HR 8X8	8	23.89	3.83	14.68	17.73	30.41
6 HR 8X8	8	25.51	4.04	16.33	20.14	31.03
8 HR 8X8	8	26.67	3.11	9.70	22.94	33.32

Adhesion Data

- **The below graphs and ANOVA comparison details the adhesion strength at the different time intervals for the 2 x 2-mm die size: -**



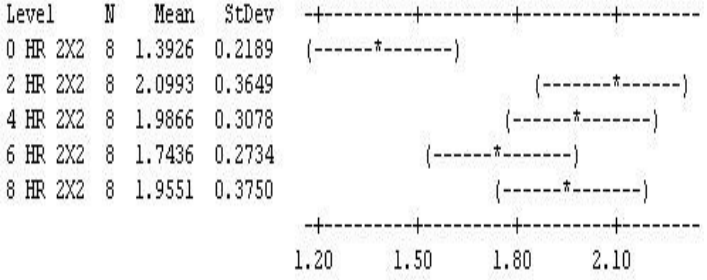
One-way ANOVA: 0 HR 2X2, 2 HR 2X2, 4 HR 2X2, 6 HR 2X2, 8 HR 2X2

Source	DF	SS	MS	F	P
Factor	4	2.4903	0.6226	6.34	0.001
Error	35	3.4383	0.0982		
Total	39	5.9287			

S = 0.3134 R-Sq = 42.01% R-Sq(adj) = 35.38%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev
0 HR 2X2	8	1.3926	0.2189
2 HR 2X2	8	2.0993	0.3649
4 HR 2X2	8	1.9866	0.3078
6 HR 2X2	8	1.7436	0.2734
8 HR 2X2	8	1.9551	0.3750

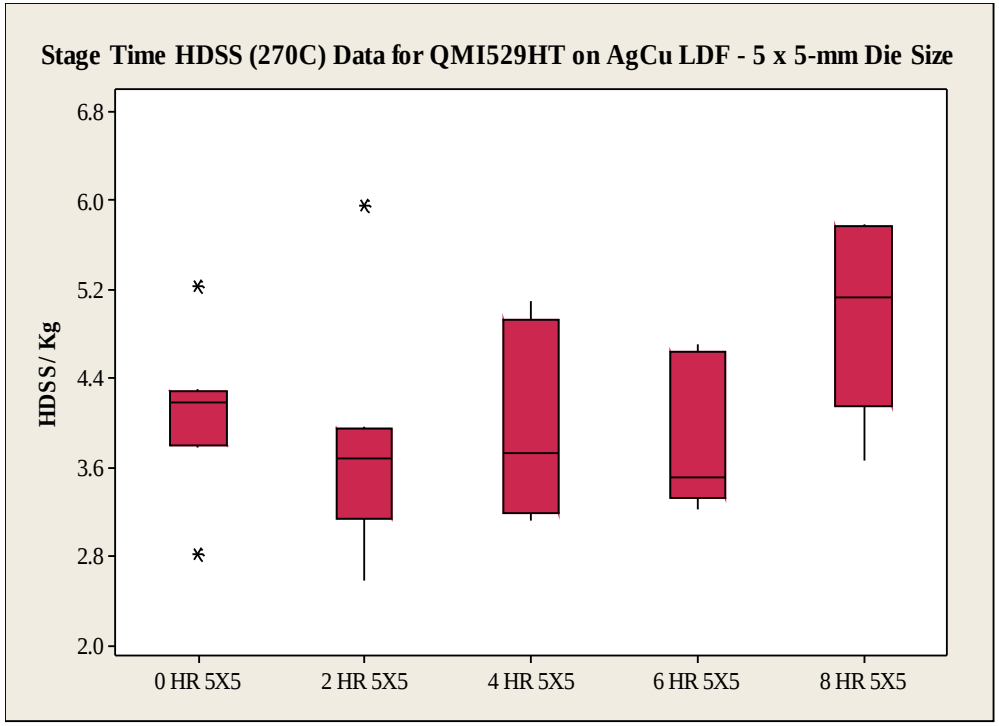


Pooled StDev = 0.3134

No effect on adhesion strength as a function of staging time!

Adhesion Data

- **The below graphs and ANOVA comparison details the adhesion strength at the different time intervals for the 5 x 5-mm die size: -**



One-way ANOVA: 0 HR 5X5, 2 HR 5X5, 4 HR 5X5, 6 HR 5X5, 8 HR 5X5

Source	DF	SS	MS	F	P
Factor	4	25.60	6.40	1.81	0.149
Error	35	123.67	3.53		
Total	39	149.27			

S = 1.880 R-Sq = 17.15% R-Sq(adj) = 7.68%

Individual 95% CIs For Mean Based on Pooled StDev

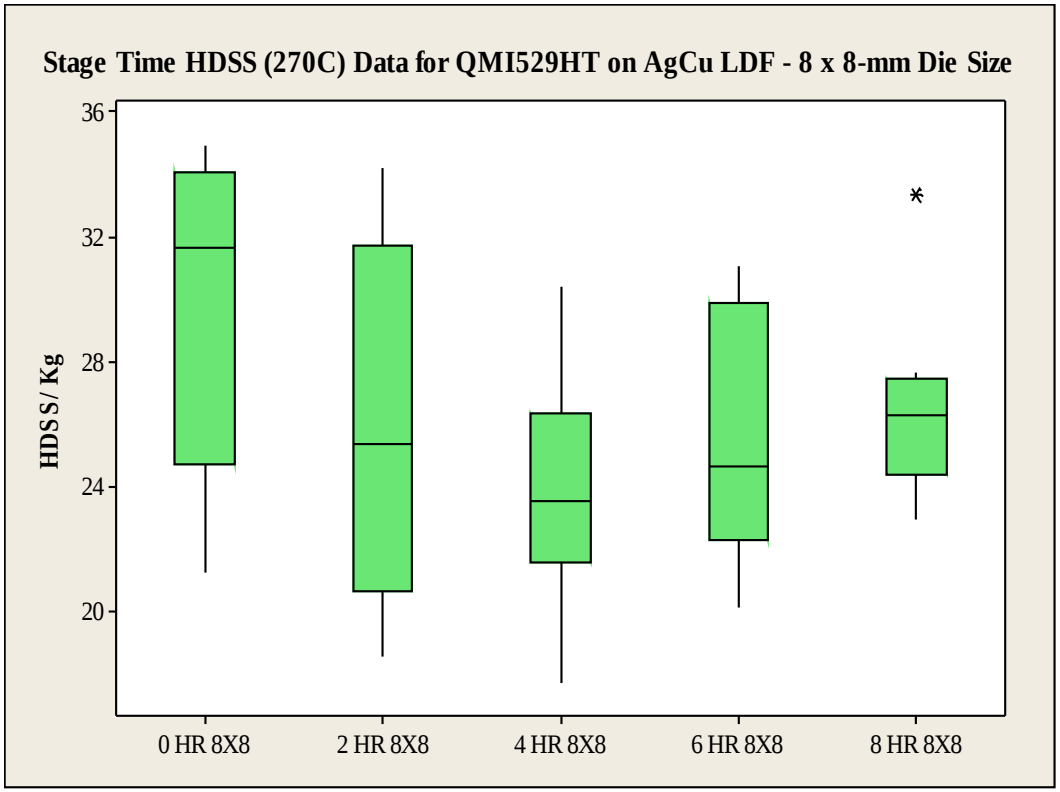
Level	N	Mean	StDev	----+---------+---------+---------+-----
0 HR 5X5	8	4.078	0.671	(--------*--------)
2 HR 5X5	8	3.776	0.994	(--------*--------)
4 HR 5X5	8	3.990	0.830	(--------*--------)
6 HR 5X5	8	4.395	1.992	(--------*--------)
8 HR 5X5	8	5.997	3.402	(--------*--------)
				----+---------+---------+---------+-----
				3.0 4.5 6.0 7.5

Pooled StDev = 1.880

No effect on adhesion strength as a function of staging time!

Adhesion Data

- **The below graphs and ANOVA comparison details the adhesion strength at the different time intervals for the 8 x 8-mm die size: -**



One-way ANOVA: 0 HR 8X8, 2 HR 8X8, 4 HR 8X8, 6 HR 8X8, 8 HR 8X8

Source	DF	SS	MS	F	P
Factor	4	156.9	39.2	1.94	0.125
Error	35	706.4	20.2		
Total	39	863.3			

S = 4.493 R-Sq = 18.17% R-Sq(adj) = 8.82%

Level	N	Mean	StDev
0 HR 8X8	8	29.886	5.100
2 HR 8X8	8	25.830	5.848
4 HR 8X8	8	23.894	3.831
6 HR 8X8	8	25.510	4.041
8 HR 8X8	8	26.667	3.114

Individual 95% CIs For Mean Based on Pooled StDev

```
-+---------+---------+---------+--------
                  (--------*---------)
        (--------*--------)
(--------*--------)
      (--------*--------)
         (--------*--------)
-+---------+---------+---------+--------
21.0      24.5      28.0      31.5
```

Pooled StDev = 4.493

No effect on adhesion strength as a function of staging time!

Conclusions

- No increase in bond line voiding as a function of adhesive stage time.
- There is an observed increase in bleed with increased stage time albeit that the observed increase is relatively minor.
- The adhesion of QMI529HT remains unaffected after extended stage times.

- Recommendation
  - QMI529HT is not sensitive in respect of stage time periods up to 8 hours.

Henkel

A Brand like a friend

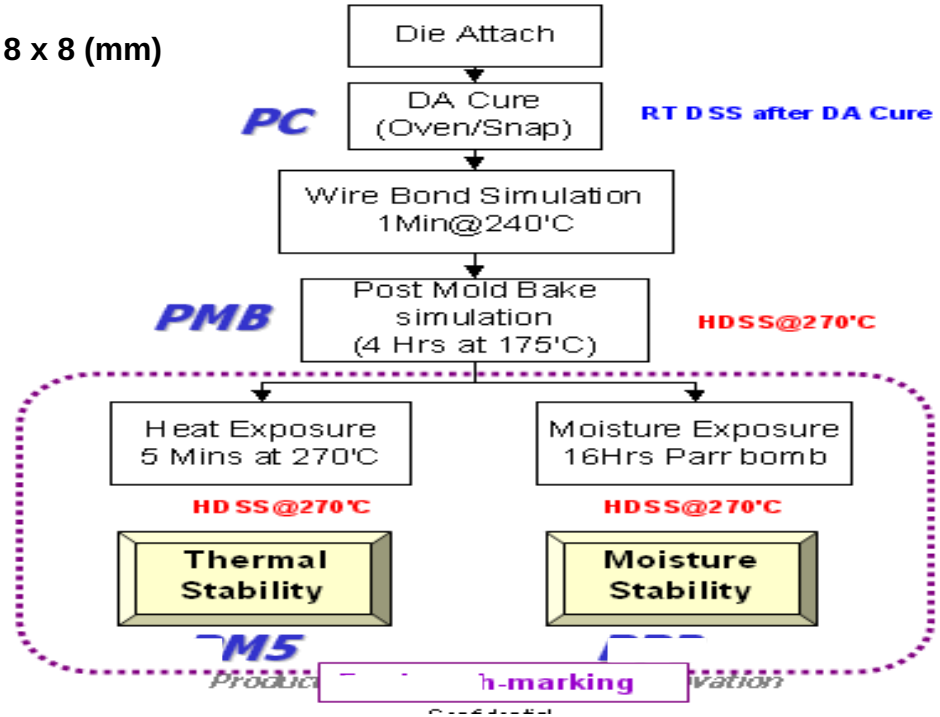
Adhesion Study For QMI529HT on Different Leadframes Surface and At Different Test Intervals.

Background

- **Adhesion needs to verified for QMI529HTon all 3 standard substrate surfaces at various different conditioning steps and at three different die sizes.**

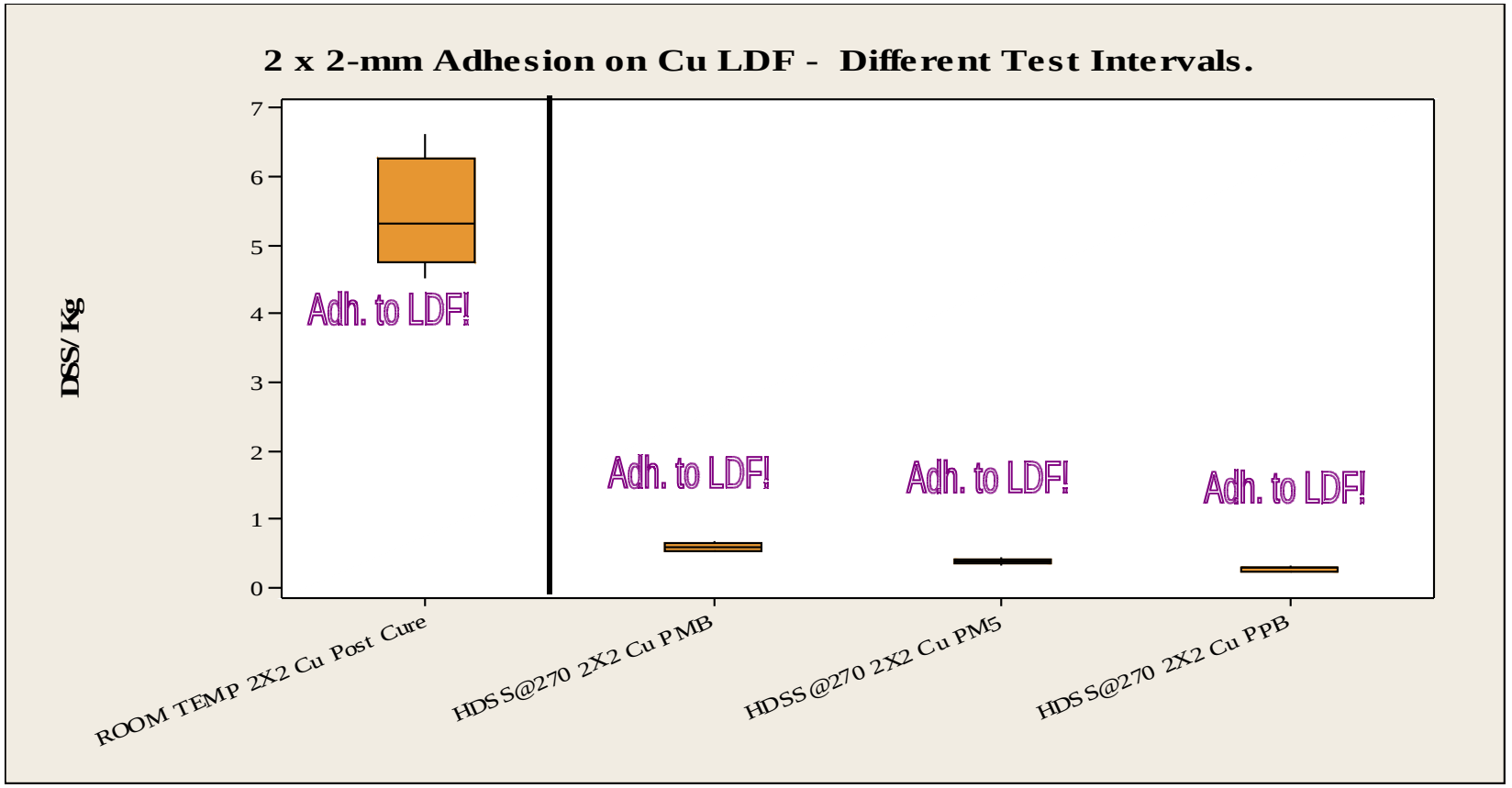
Leadframes: Cu, AgCu, PPF.

Die Sizes: 2 x 2, 5 x 5, 8 x 8 (mm)



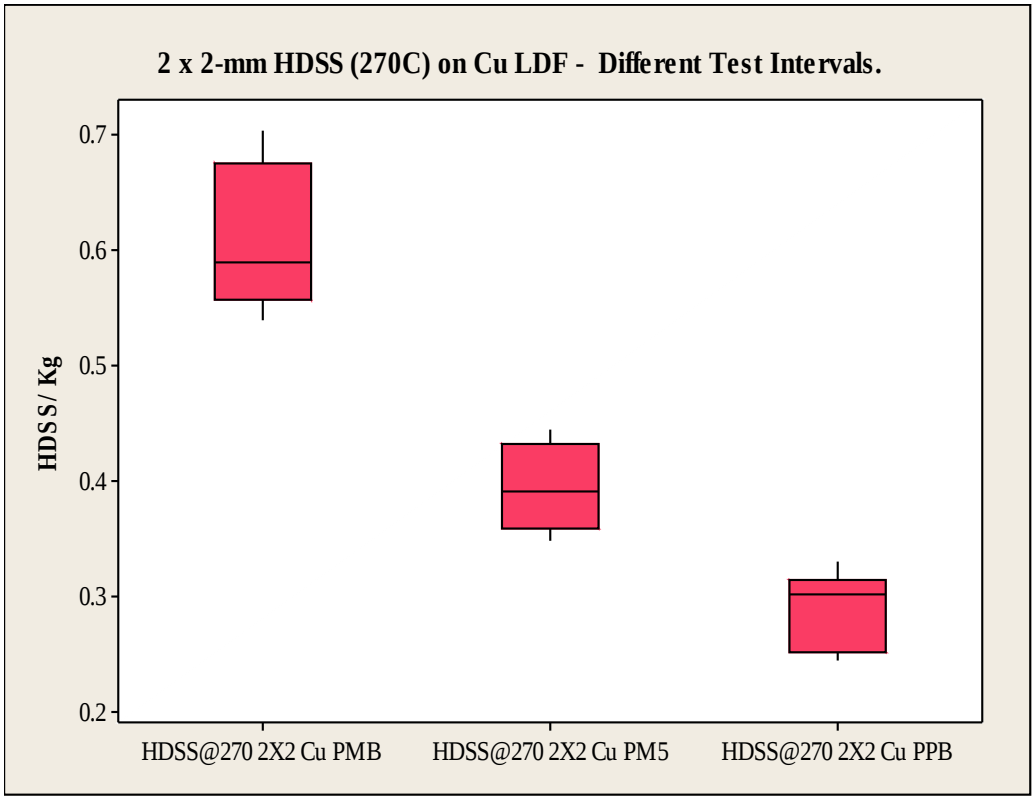
Adhesion on Cu
2 x 2-mm Die Size

- The adhesion was measured for 2 x 2-mm die size on Cu LDF in accordance with the test matrix: -



Adhesion on Cu
2 x 2-mm Die Size

- The below box plot and ANOVA analysis compares HDSS (270℃) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -



One-way ANOVA: HDSS@270 2X2 Cu PMB, HDSS@270 2X2 Cu PM5, HDSS@270 2X2 Cu PPB

Source	DF	SS	MS	F	P
Factor	2	0.31655	0.15828	77.75	0.000
Error	17	0.03483	0.00205		
Total	19	0.35138			

S = 0.04526 R-Sq = 90.14% R-Sq(adj) = 88.99%

Level	N	Mean	StDev
HDSS@270 2X2 Cu PMB	6	0.60833	0.06327
HDSS@270 2X2 Cu PM5	8	0.39413	0.03623
HDSS@270 2X2 Cu PPB	6	0.29000	0.03354

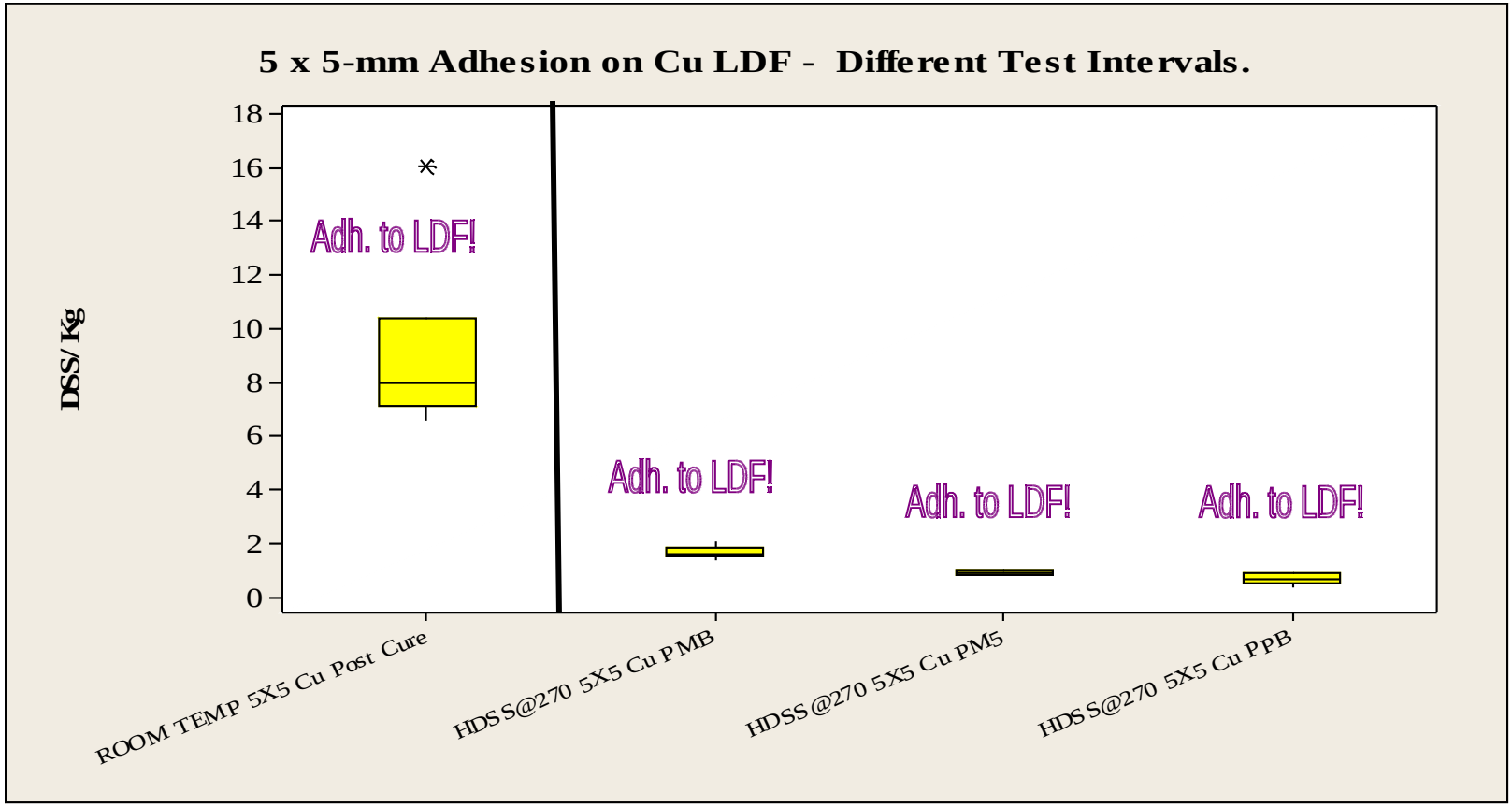
Individual 95% CIs For Mean Based on Pooled StDev

Pooled StDev = 0.04526

Adhesion to the Cu LDF used in this test was poor!

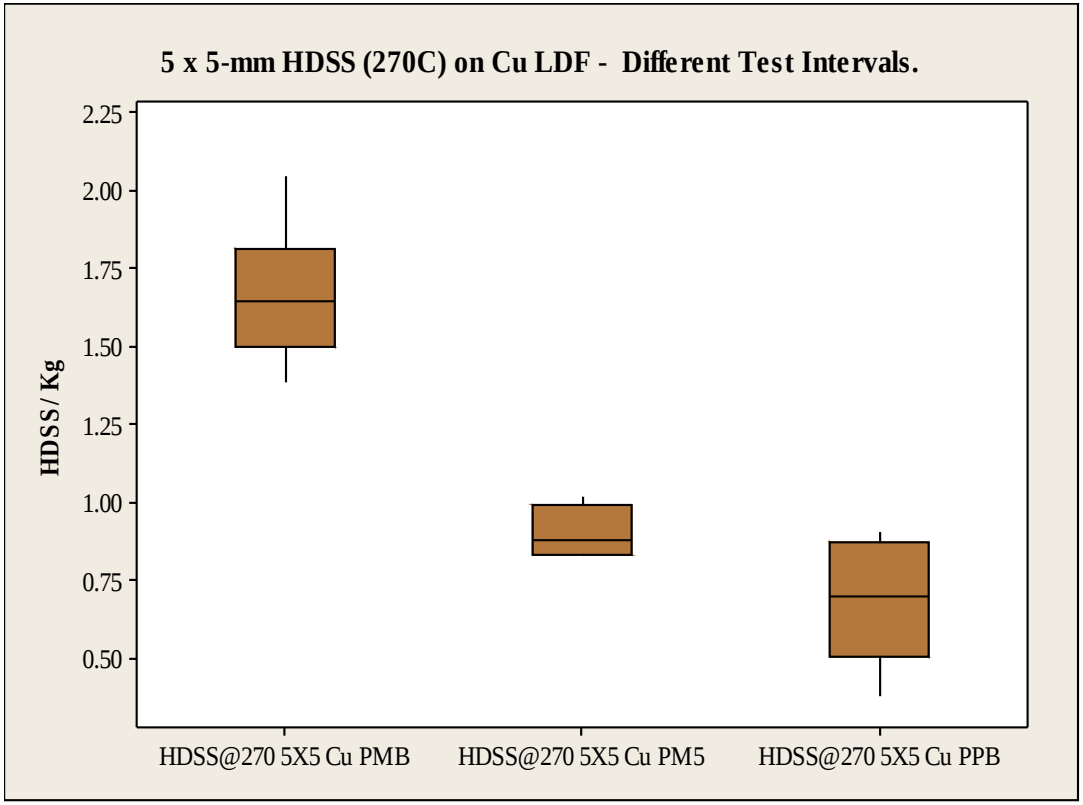
Adhesion on Cu
5 x 5-mm Die Size

- The adhesion was measured for 5 x 5-mm die size on Cu LDF in accordance with the test matrix: -



Adhesion on Cu
5 x 5-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**



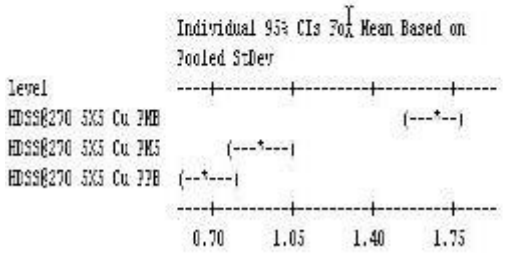
One-way ANOVA: HDSS@270 5X5 Cu PMB, HDSS@270 5X5 Cu PM5, HDSS@270 5X5 Cu PPB

Source	DF	SS	MS	F	P
Factor	2	4.3026	2.1513	71.30	0.000
Error	21	0.6336	0.0302		
Total	23	4.9362			

S = 0.1737 R-Sq = 87.16% R-Sq(adj) = 85.94%

Level	N	Mean	StDev
HDSS@270 5X5 Cu PMB	8	1.6686	0.2113
HDSS@270 5X5 Cu PM5	8	0.9065	0.0821
HDSS@270 5X5 Cu PPB	8	0.6784	0.1978

Individual 95% CIs For Mean Based on Pooled StDev

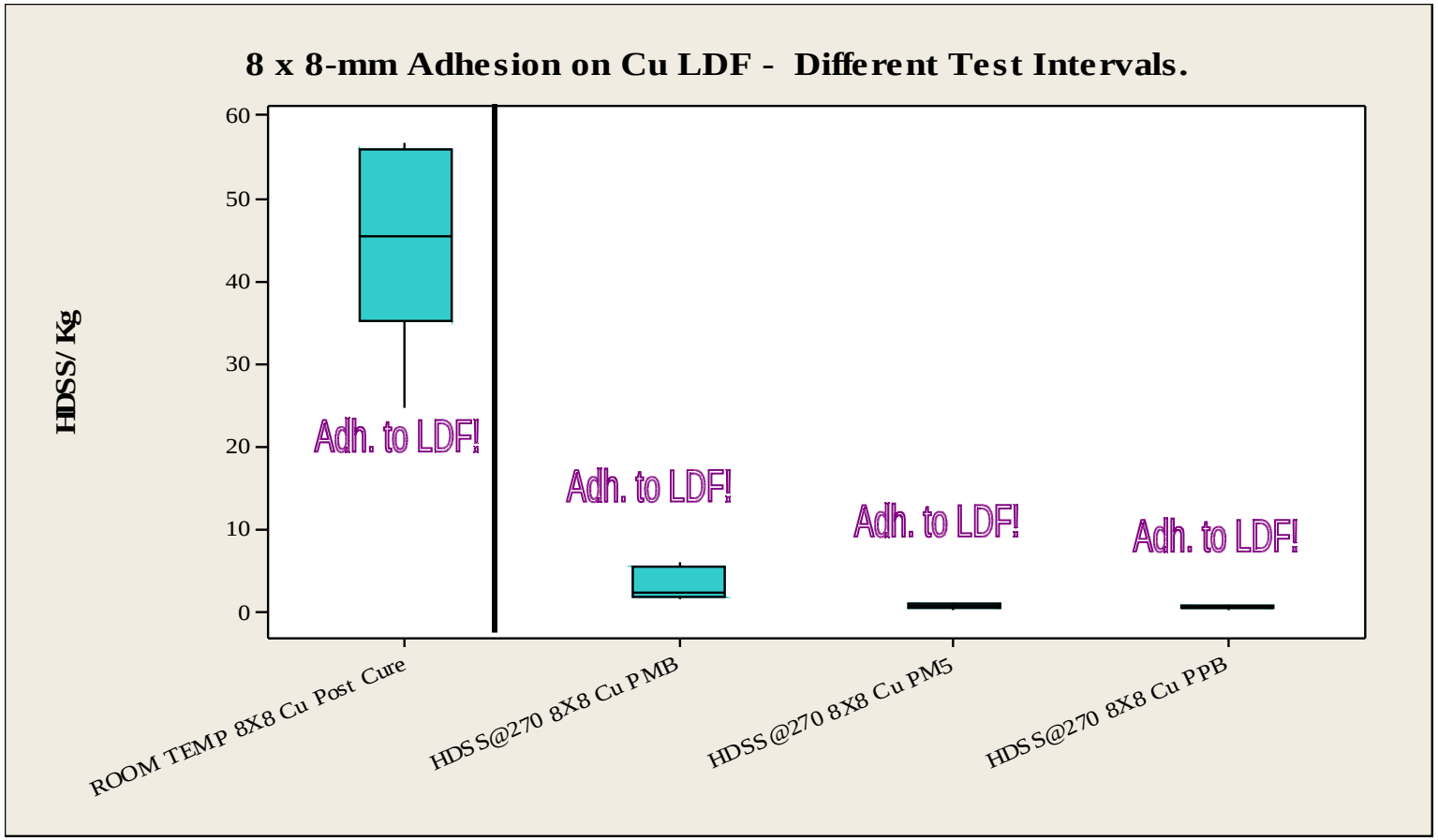


Pooled StDev = 0.1737

Adhesion to the Cu LDF used in this test was poor!

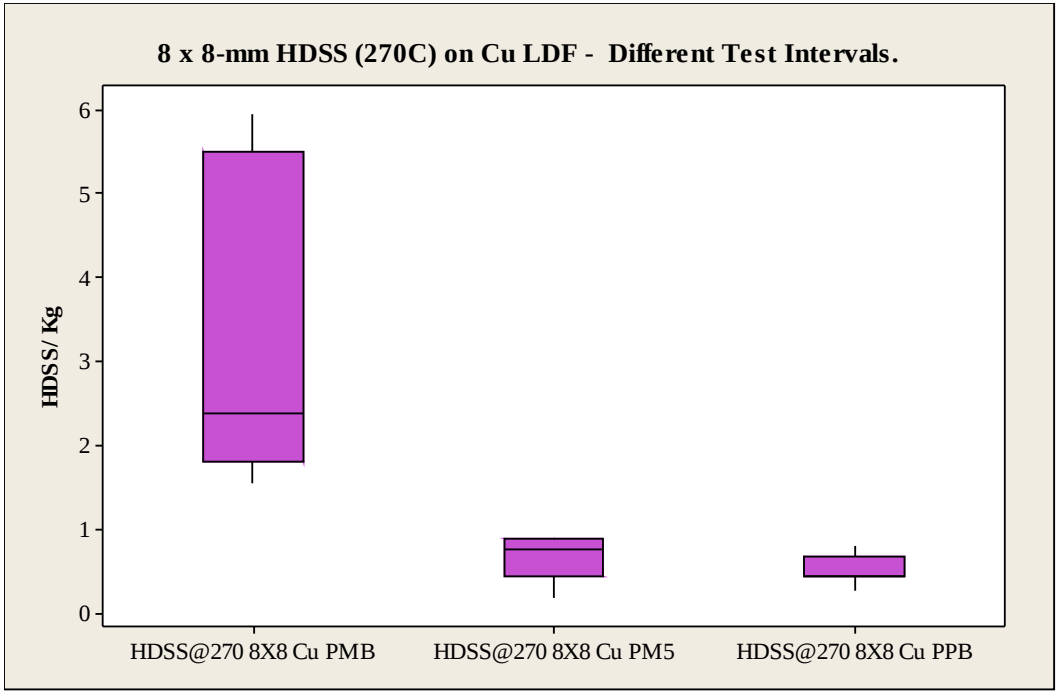
Adhesion on Cu
8 x 8-mm Die Size

- **The adhesion was measured for 8 x 8-mm die size on Cu LDF in accordance with the test matrix: -**



Adhesion on Cu
8 x 8-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**



One-way ANOVA: HDSS@270 8X8 Cu PMB, HDSS@270 8X8 Cu PM5, HDSS@270 8X8 Cu PPB

Source	DF	SS	MS	F	P
Factor	2	39.25	19.62	14.31	0.000
Error	19	26.05	1.37		
Total	21	65.30			

S = 1.171 R-Sq = 60.10% R-Sq(adj) = 55.90%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev
HDSS@270 8X8 Cu PMB	8	3.371	1.908
HDSS@270 8X8 Cu PM5	7	0.651	0.357
HDSS@270 8X8 Cu PPB	7	0.541	0.179

0.0 1.2 2.4 3.5

Pooled StDev = 1.171

Adhesion to the Cu LDF used in this test was poor!

Basic Statistics on Cu LDF

- The following Basics Statistics were obtained for QMI529HT on Cu LDF: -

2 x 2-mm

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
ROOM TEMP 2X2 Cu Post Cu	8	5.502	0.798	0.637	4.530	6.630
HDSS@270 2X2 Cu PMB	6	0.6083	0.0633	0.0040	0.5390	0.7030
HDSS@270 2X2 Cu PM5	8	0.3941	0.0362	0.0013	0.3480	0.4440
HDSS@270 2X2 Cu PPB	6	0.2900	0.0335	0.0011	0.2440	0.3300

5 x 5-mm

ROOM TEMP 5X5 Cu Post Cu	7	9.23	3.30	10.86	6.59	16.06
HDSS@270 5X5 Cu PMB	8	1.6686	0.2113	0.0447	1.3880	2.0480
HDSS@270 5X5 Cu PM5	8	0.9065	0.0821	0.0067	0.8310	1.0200
HDSS@270 5X5 Cu PPB	8	0.6784	0.1978	0.0391	0.3800	0.9090

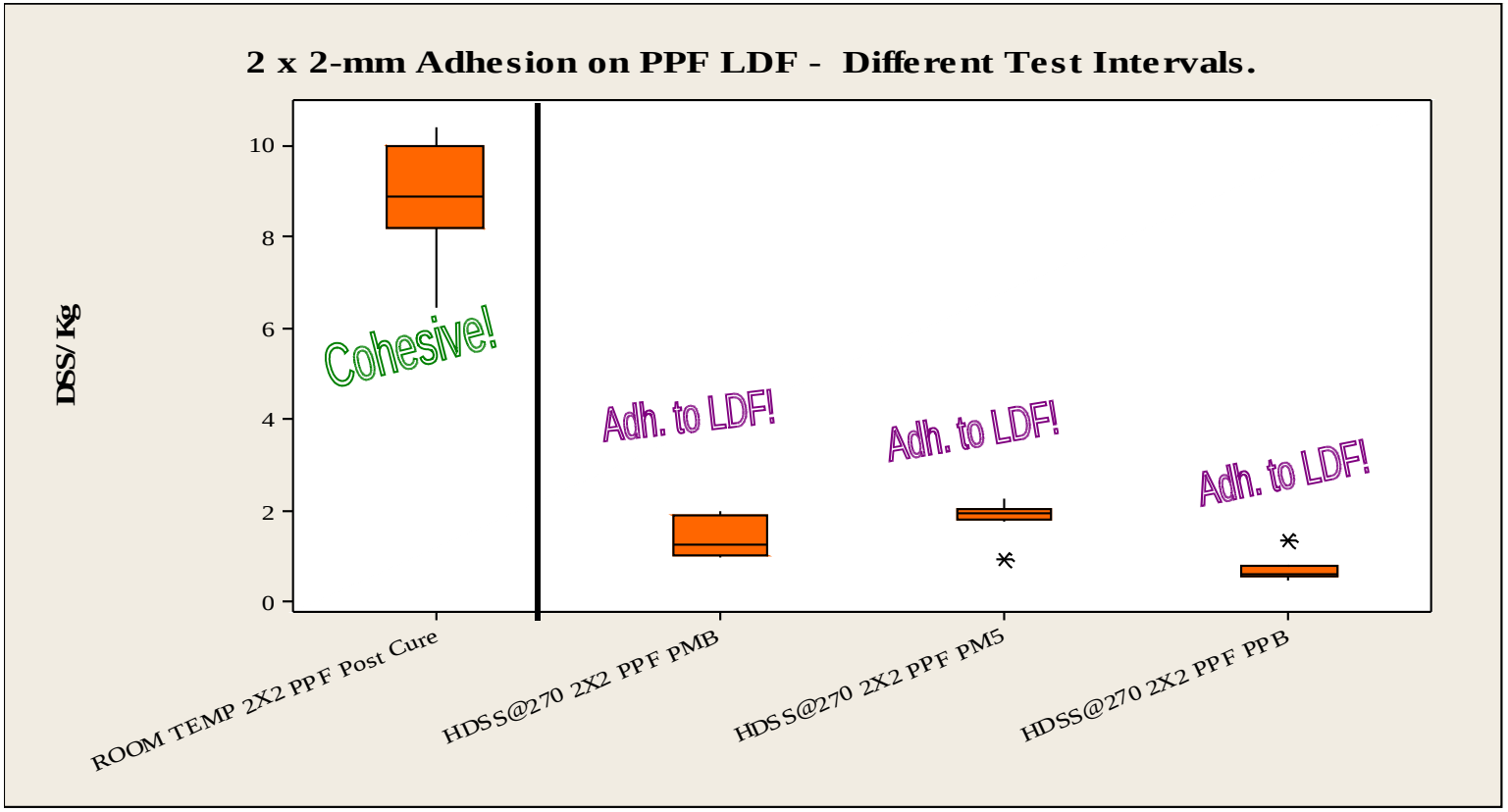
8 x 8-mm

ROOM TEMP 8X8 Cu Post Cu	8	44.49	11.80	139.12	24.53	56.65
HDSS@270 8X8 Cu PMB	8	3.371	1.908	3.639	1.553	5.941
HDSS@270 8X8 Cu PM5	7	0.6513	0.2568	0.0660	0.1990	0.8970
HDSS@270 8X8 Cu PPB	7	0.5414	0.1792	0.0321	0.2810	0.8060

Adhesion on PPF
2 x 2-mm Die Size

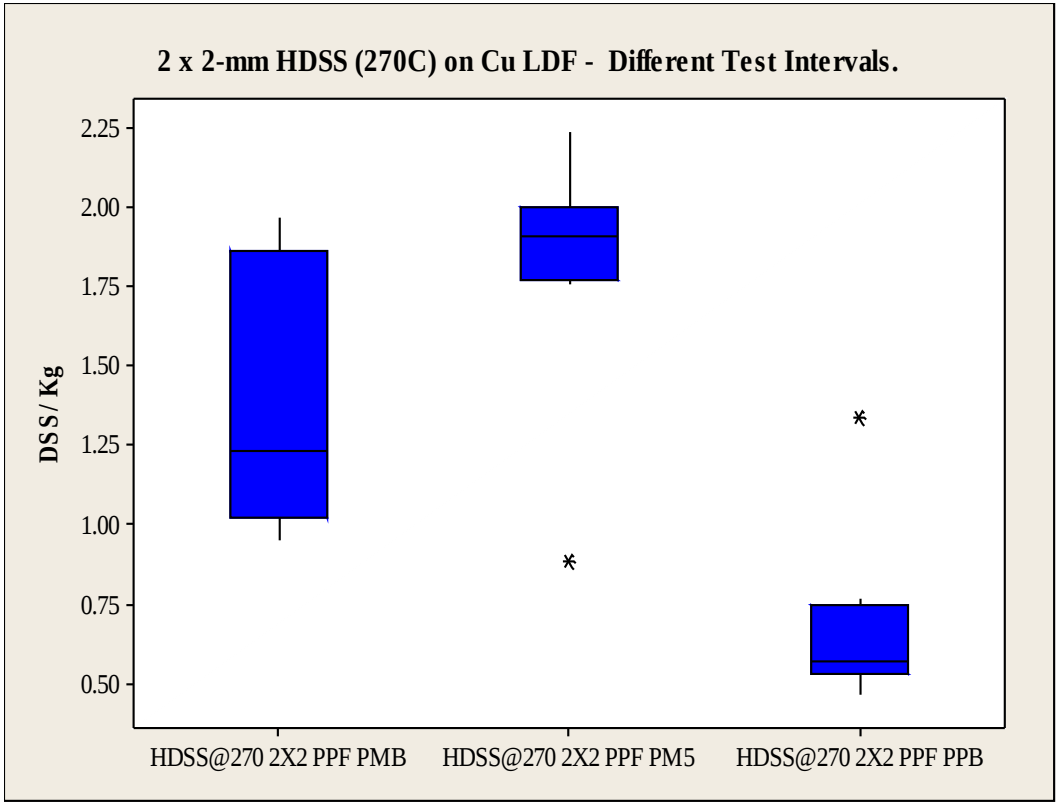
- The adhesion was measured for 2 x 2-mm die size on PPF LDF in accordance with the test matrix:

-



Adhesion on PPF
2 x 2-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**

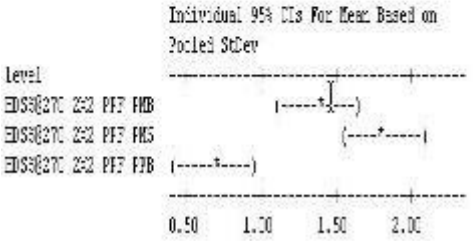


One-way ANOVA: HDSS@270 2X2 PPF PMB, HDSS@270 2X2 PPF PM5, HDSS@270 2X2 PPF PPB

Source	DF	SS	MS	F	P
Factor	2	5.141	2.571	19.18	0.000
Error	21	2.814	0.134		
Total	23	7.955			

S = 0.3661 R-Sq = 64.63% R-Sq(adj) = 61.26%

Level	N	Mean	StDev
HDSS@270 2X2 PPF PMB	8	1.3785	0.4054
HDSS@270 2X2 PPF PM5	8	1.3063	0.3978
HDSS@270 2X2 PPF PPB	8	0.5831	0.2818

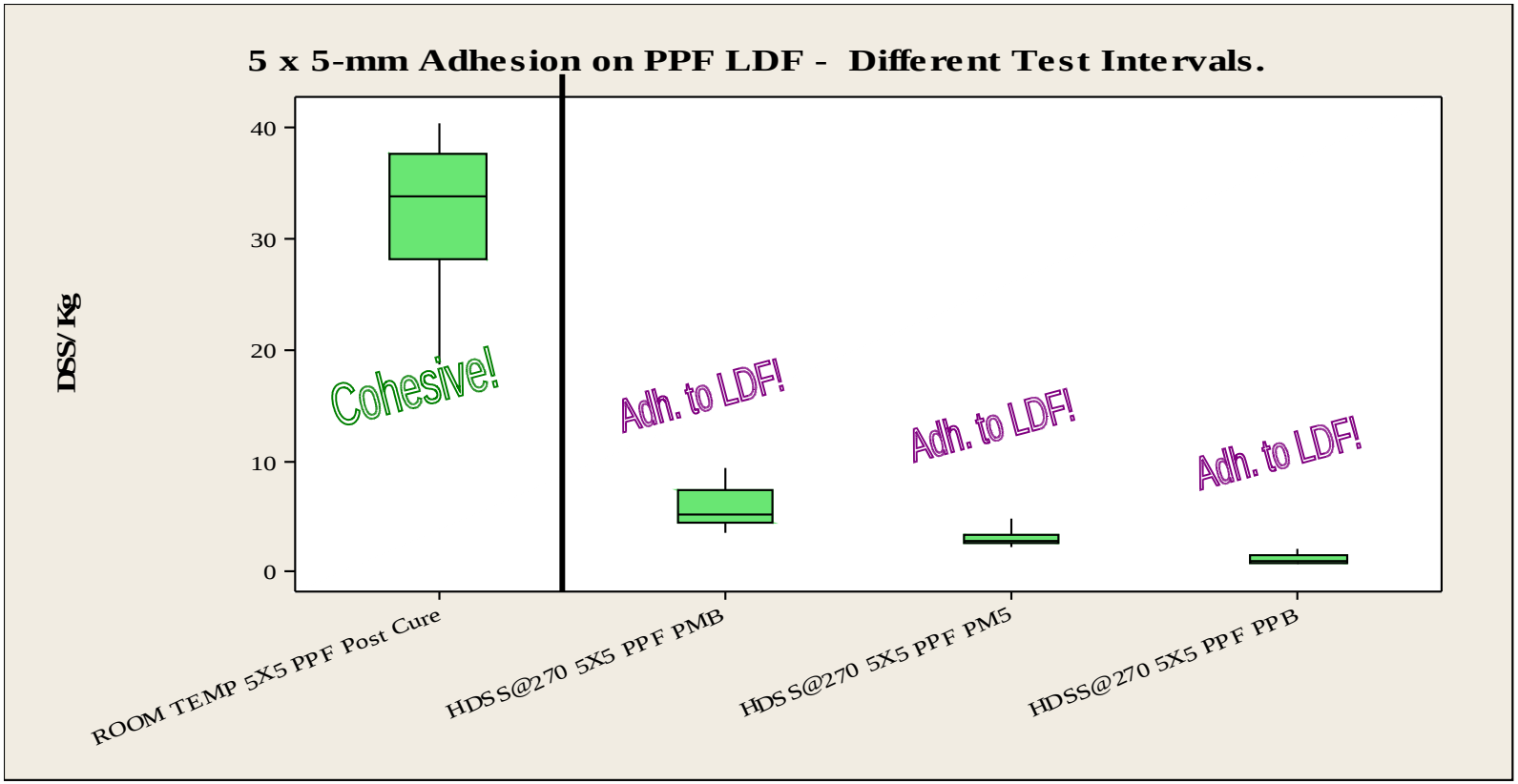


Pooled StDev = 0.3661

No reduction in adhesion to PPF after PM5 conditioning.
Adhesion PPB is significantly reduced

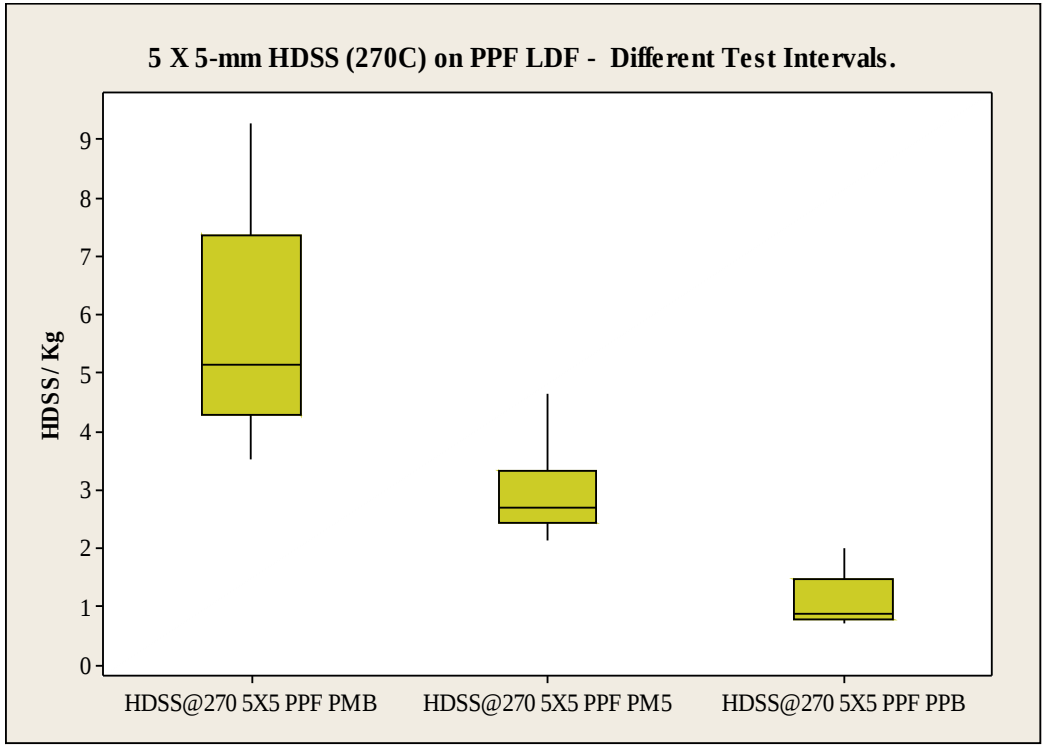
Adhesion on PPF
5 x 5-mm Die Size

- **The adhesion was measured for 5 x 5-mm die size on PPF LDF in accordance with the test matrix: -**



Adhesion on PPF
5 x 5-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**



One-way ANOVA: HDSS@270 5X5 PPF PMB, HDSS@270 5X5 PPF PM5, HDSS@270 5X5 PPF PPB

Source	DF	SS	MS	F	P
Factor	2	87.35	43.66	23.60	0.000
Error	21	38.07	1.85		
Total	23	119.42			

S = 1.236 R-Sq = 73.15% R-Sq(adj) = 70.59%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev
HDSS@270 5X5 PPF PMB	8	5.754	1.529
HDSS@270 5X5 PPF PM5	8	2.951	0.799
HDSS@270 5X5 PPF PPB	8	1.114	0.469

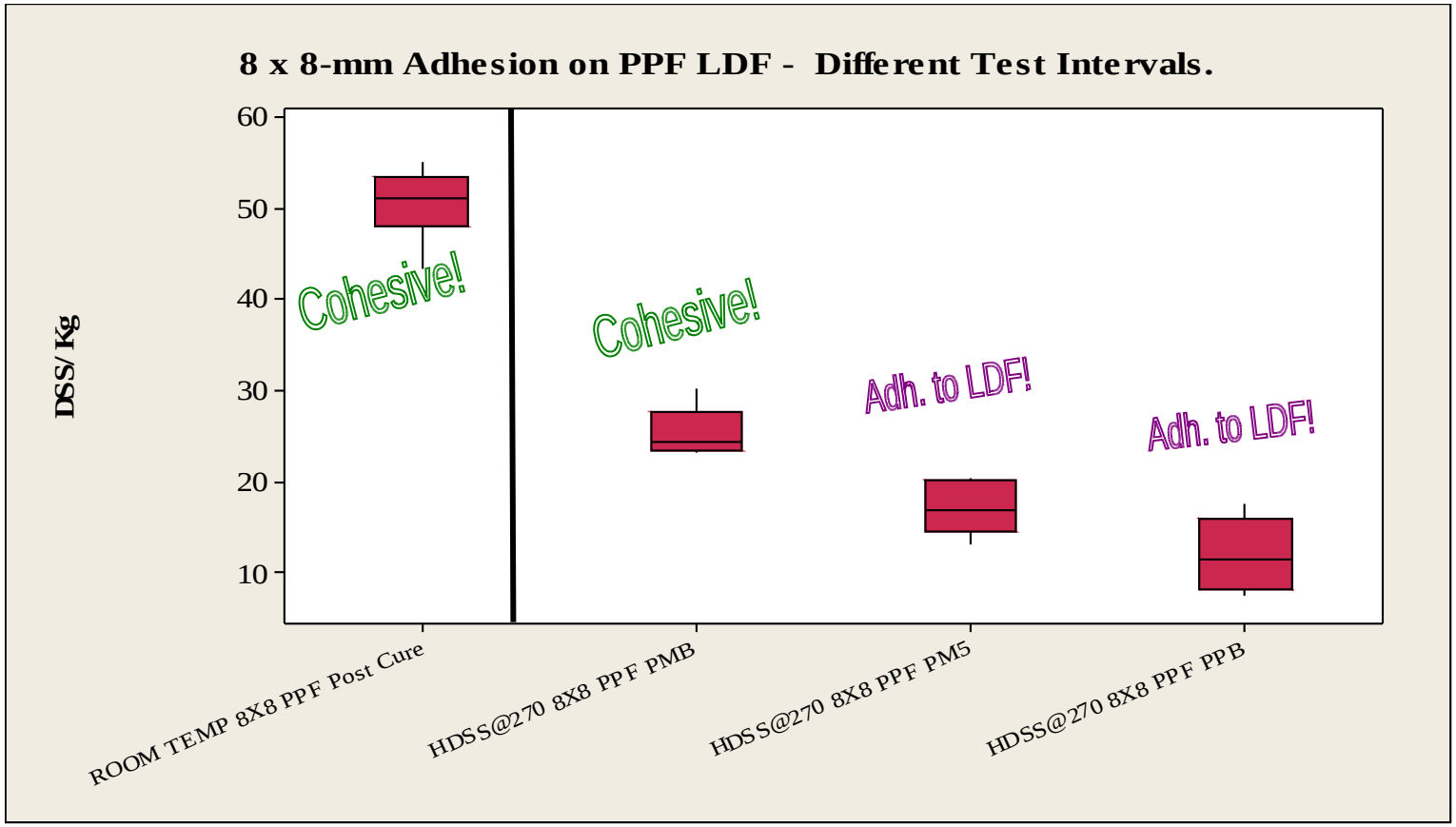
2.0 4.0 6.0 8.0

Pooled StDev = 1.236

Gradual reduction in adhesion with increased conditioning severity!

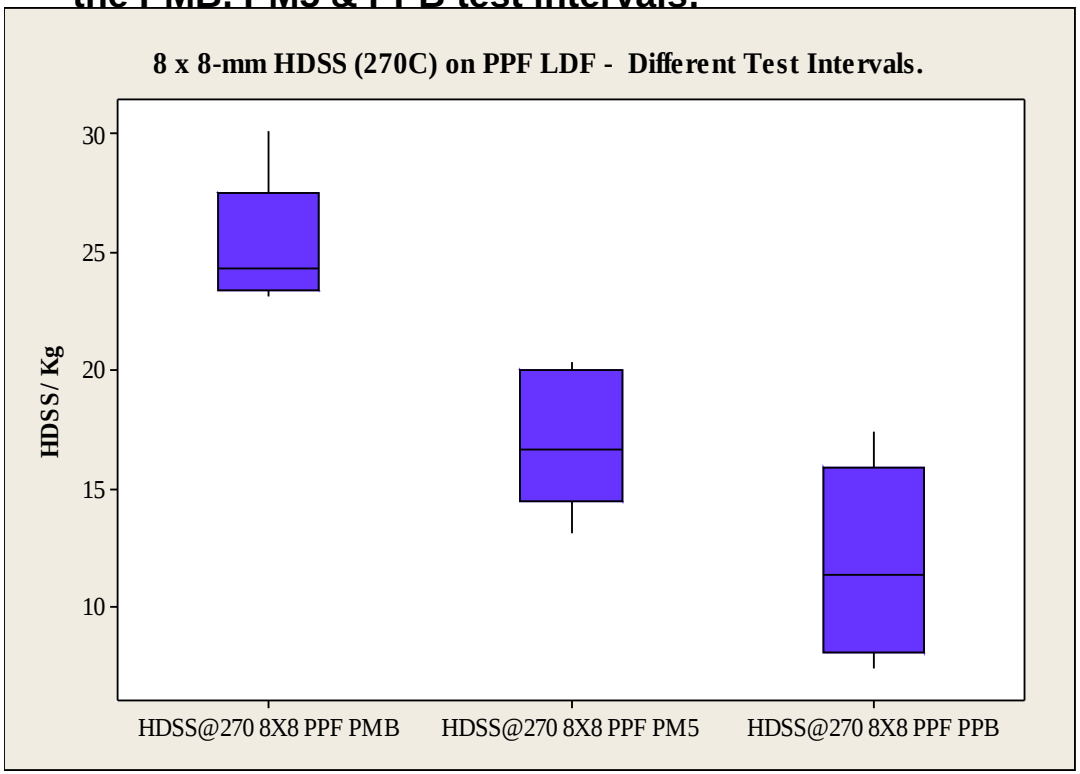
Adhesion on PPF
8 x 8-mm Die Size

- **The adhesion was measured for 8 x 8-mm die size on PPF LDF in accordance with the test matrix: -**



Adhesion on PPF
8 x 8-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**

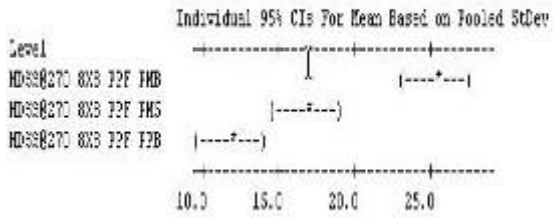


One-way ANOVA: HDSS@270 8X8 PPF PMB, HDSS@270 8X8 PPF PM5, HDSS@270 8X8 PPF PPB

Source	DF	SS	MS	F	P
Factor	2	707.23	353.61	36.23	0.000
Error	21	202.49	9.64		
Total	23	909.72			

S = 3.105 R-Sq = 78.45% R-Sq(adj) = 76.43%

Level	N	Mean	StDev
HDSS@270 8X8 PPF PMB	8	25.324	2.563
HDSS@270 8X8 PPF PM5	8	16.887	2.817
HDSS@270 8X8 PPF PPB	8	11.895	3.798



Pooled StDev = 3.105

Gradual reduction in adhesion with increased conditioning severity!

Basic Statistics on PPF LDF

- **The following Basics Statistics were obtained for QMI529HT on PPF LDF: -**

2 x 2-mm

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
ROOM TEMP 2X2 PPF Post C	8	8.838	1.270	1.613	6.419	10.392
HDSS@270 2X2 PPF PMB	8	1.379	0.405	0.164	0.950	1.964
HDSS@270 2X2 PPF PM5	8	1.806	0.398	0.158	0.888	2.232
HDSS@270 2X2 PPF PPB	8	0.6831	0.2818	0.0794	0.4680	1.3400

5 x 5-mm

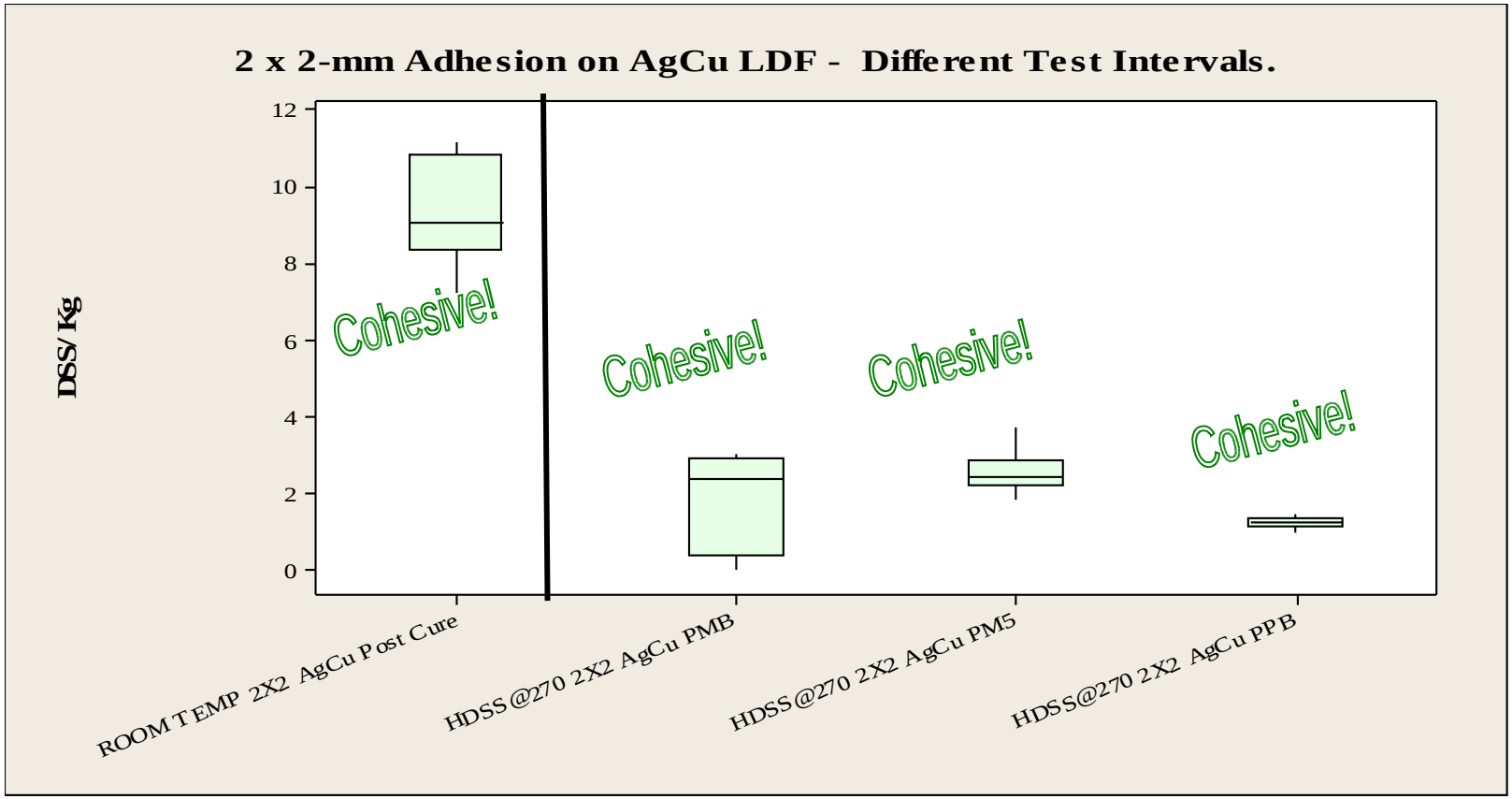
ROOM TEMP 5X5 PPF Post C	8	32.52	7.07	49.95	18.62	40.41
HDSS@270 5X5 PPF PMB	8	5.754	1.929	3.723	3.520	9.290
HDSS@270 5X5 PPF PM5	8	2.951	0.799	0.638	2.143	4.665
HDSS@270 5X5 PPF PPB	8	1.114	0.469	0.220	0.707	2.018

8 x 8-mm

ROOM TEMP 8X8 PPF Post C	8	50.56	3.87	14.99	43.25	55.04
HDSS@270 8X8 PPF PMB	8	25.324	2.563	6.567	23.169	30.095
HDSS@270 8X8 PPF PM5	8	16.887	2.817	7.935	13.118	20.352
HDSS@270 8X8 PPF PPB	8	11.89	3.80	14.43	7.42	17.45

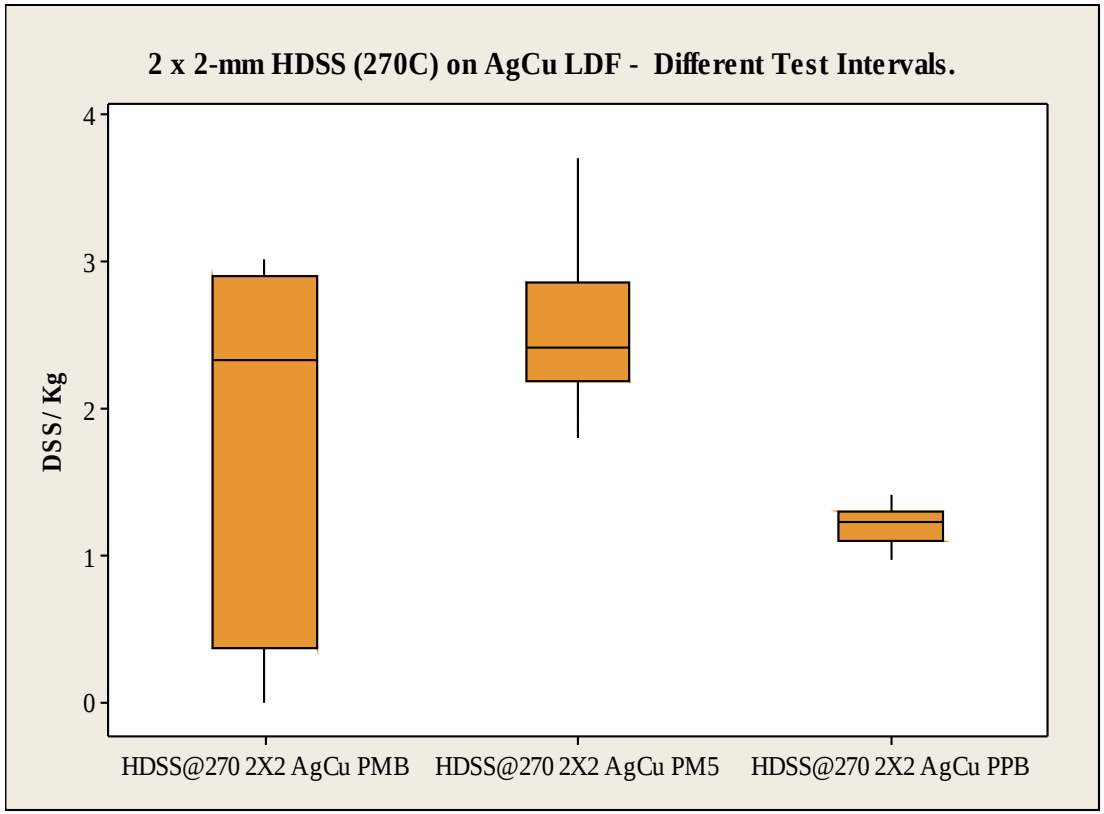
Adhesion on AgCu
2 x 2-mm Die Size

- **The adhesion was measured for 2 x 2-mm die size on PPF LDF in accordance with the test matrix: -**



Adhesion on AgCu
2 x 2-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**



One-way ANOVA: HDSS@270 2X2 AgC, HDSS@270 2X2 AgC, HDSS@270 2X2 AgC

Source	DF	SS	MS	F	P
Factor	2	7.201	3.600	5.73	0.010
Error	21	13.199	0.629		
Total	23	20.400			

S = 0.7928 R-Sq = 35.30% R-Sq(adj) = 29.14%

Level	N	Mean	StDev
HDSS@270 2X2 AgCu PMB	8	1.8600	1.2425
HDSS@270 2X2 AgCu PM5	8	2.5568	0.5684
HDSS@270 2X2 AgCu PPB	8	1.2154	0.1370

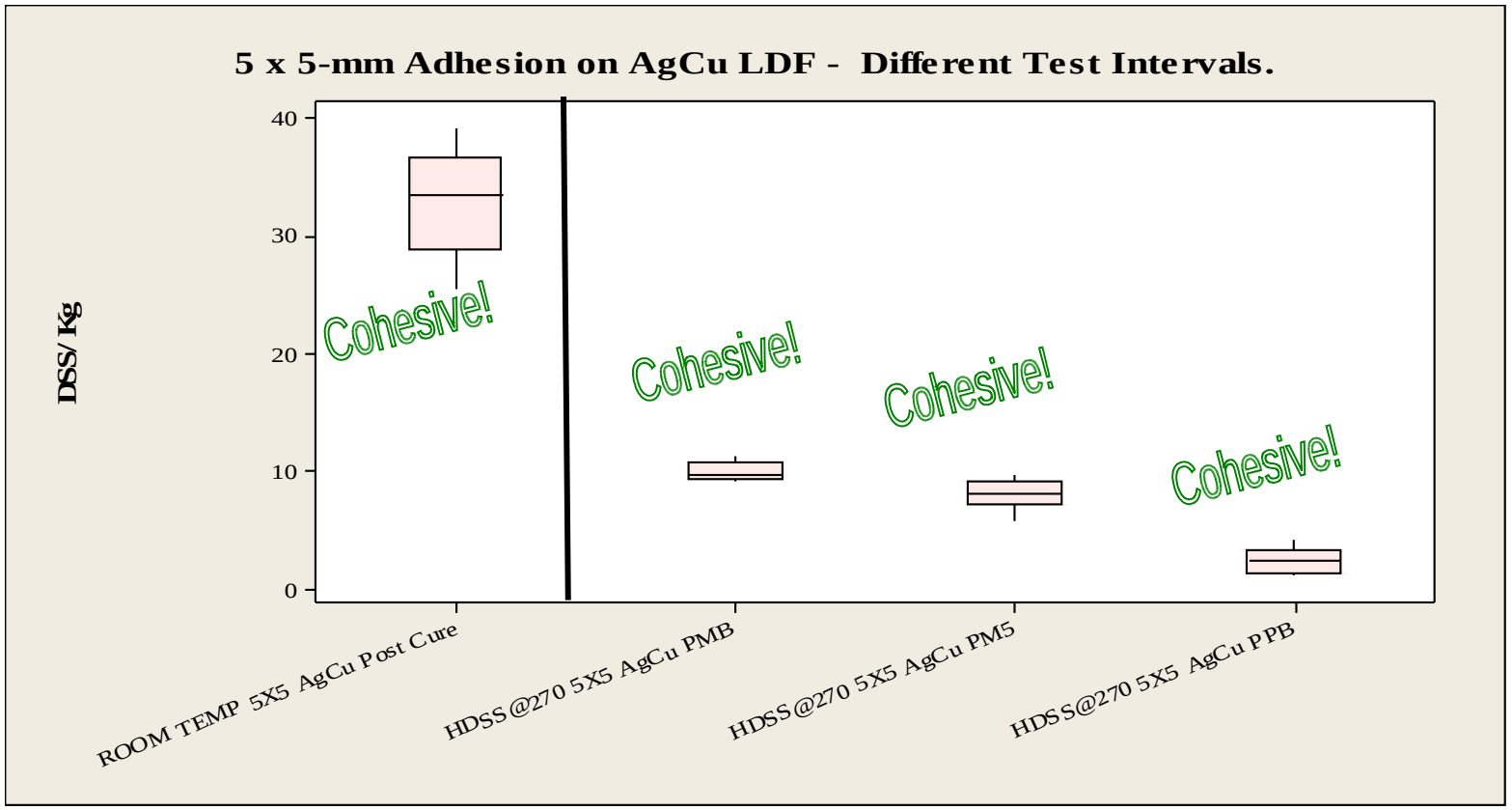
Individual 95% CIs For Mean Based on Pooled StDev

Pooled StDev = 0.7928

Only a marginal reduction in adhesion with increased conditioning severity!

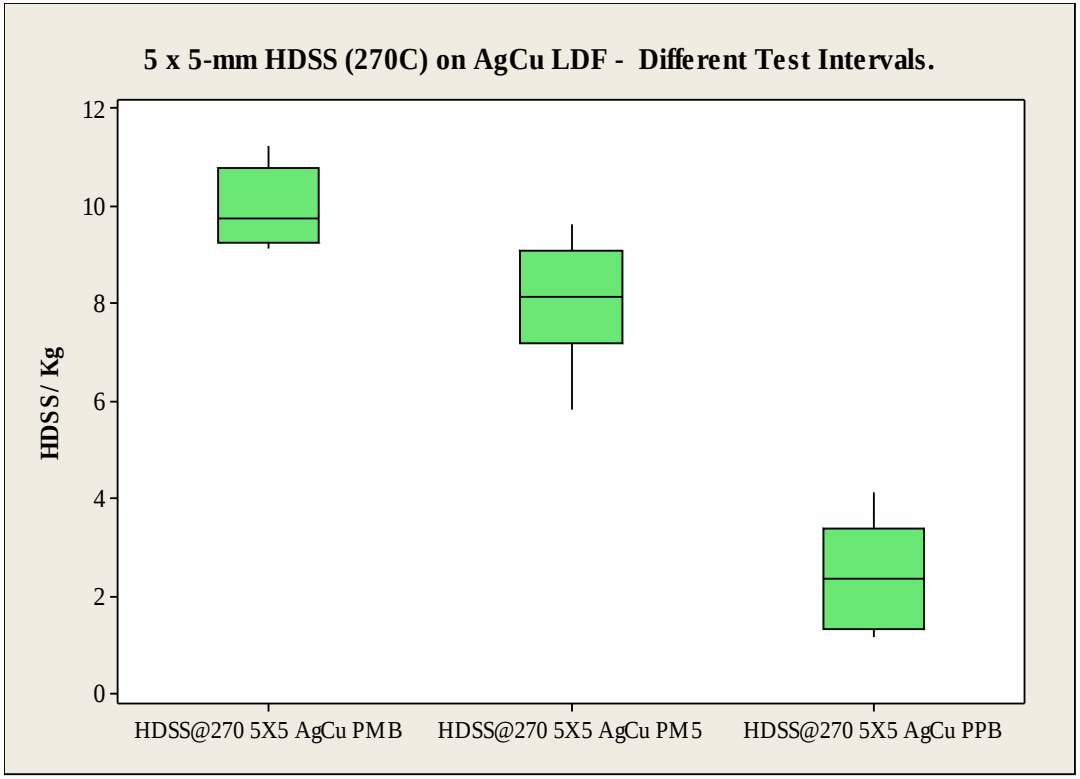
Adhesion on AgCu
5 x 5-mm Die Size

- **The adhesion was measured for 5 x 5-mm die size on PPF LDF in accordance with the test matrix: -**



Adhesion on AgCu
5 x 5-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**



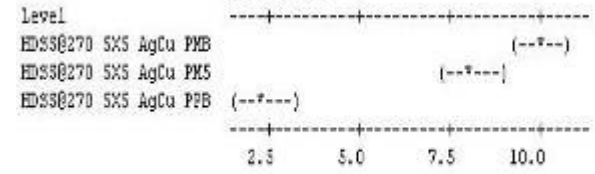
One-way ANOVA: HDSS@270 5X5 AgC, HDSS@270 5X5 AgC, HDSS@270 5X5 AgC

Source	DF	SS	MS	F	P
Factor	2	251.47	125.74	109.97	0.000
Error	21	24.01	1.14		
Total	23	275.48			

S = 1.069 R-Sq = 91.28% R-Sq(adj) = 90.45%

Level	N	Mean	StDev
HDSS@270 5X5 AgCu PMB	8	9.983	0.827
HDSS@270 5X5 AgCu PM5	8	8.099	1.247
HDSS@270 5X5 AgCu PPB	8	2.371	1.091

Individual 95% CIs For Mean Based on Pooled StDev

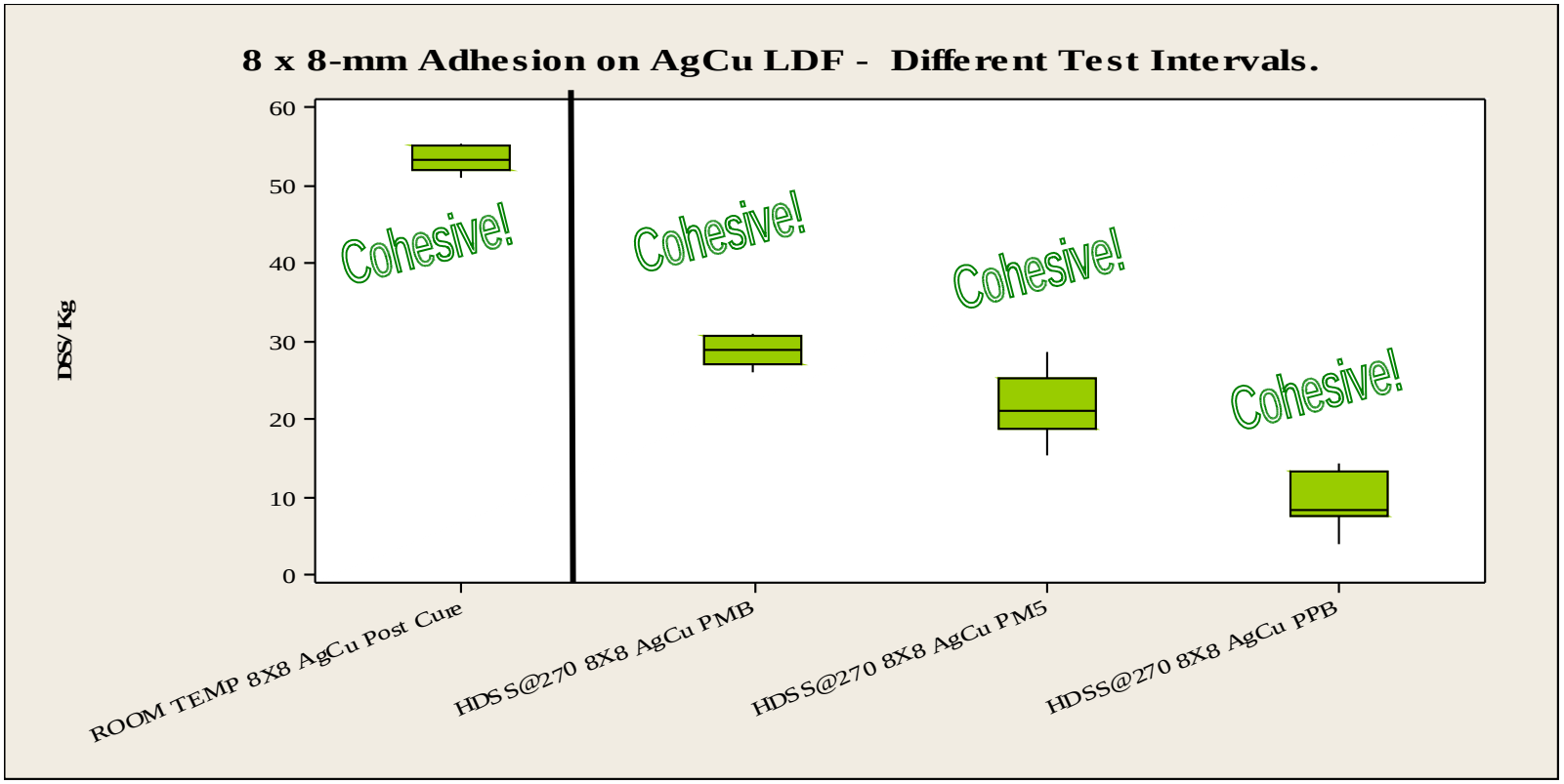


Pooled StDev = 1.069

Gradual reduction in adhesion with increased conditioning severity!

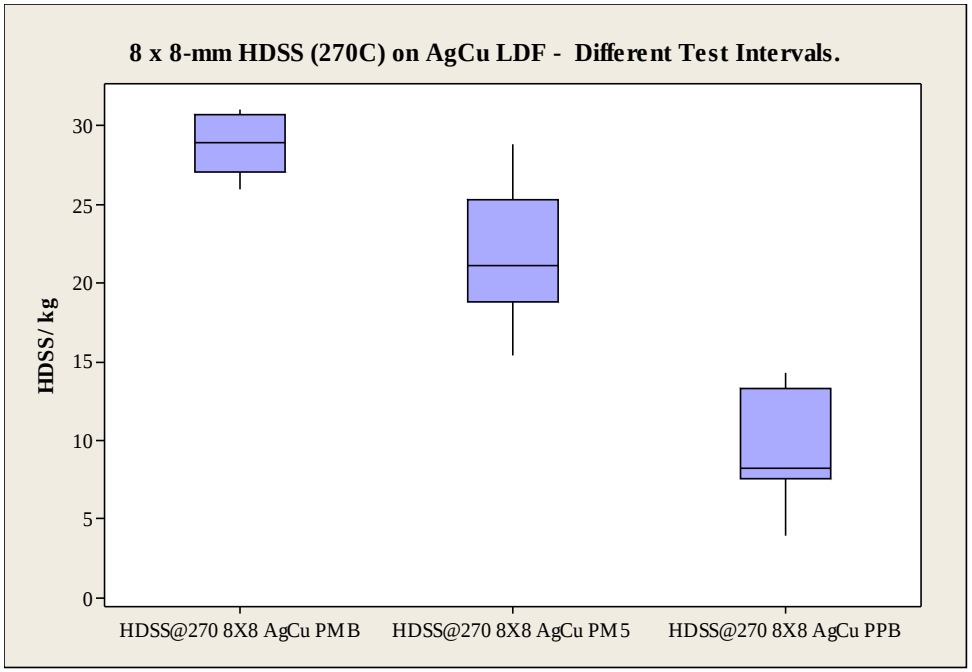
Adhesion on AgCu
8 x 8-mm Die Size

- The adhesion was measured for 8 x 8-mm die size on AgCu LDF in accordance with the test matrix: -



Adhesion on AgCu
8 x 8-mm Die Size

- **The below box plot and ANOVA analysis compares HDSS (270°C) adhesion on Cu leadframe at the PMB, PM5 & PPB test intervals: -**



One-way ANOVA: HDSS@270 8X8 AgC, HDSS@270 8X8 AgC, HDSS@270 8X8 AgC

Source	DF	SS	MS	F	P
Factor	2	1545.7	772.8	67.51	0.000
Error	21	240.4	11.4		
Total	23	1786.1			

S = 3.384 R-Sq = 86.54% R-Sq(adj) = 85.26%

Level	N	Mean	StDev
HDSS@270 8X8 AgCu PMB	8	28.849	1.943
HDSS@270 8X8 AgCu PM5	8	21.712	4.250
HDSS@270 8X8 AgCu PPB	8	9.418	3.536

Individual 95% CIs For Mean Based on Pooled StDev

Level	
HDSS@270 8X8 AgCu PMB	(--*---)
HDSS@270 8X8 AgCu PM5	(---*---)
HDSS@270 8X8 AgCu PPB	(--*---)

7.0 14.0 21.0 28.0

Pooled StDev = 3.384

Gradual reduction in adhesion with increased conditioning severity!

Basic Statistics on AgCu LDF

- **The following Basics Statistics were obtained for QMI529HT on AgCu LDF: -**

2 x 2-mm

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
ROOM TEMP 2X2 AgCu Post	8	9.344	1.391	1.935	7.196	11.136
HDSS@270 2X2 AgCu PMB	8	1.860	1.242	1.544	0.000	3.012
HDSS@270 2X2 AgCu PM5	8	2.557	0.568	0.323	1.805	3.696
HDSS@270 2X2 AgCu PPB	8	1.2154	0.1370	0.0188	0.9770	1.4160

5 x 5-mm

ROOM TEMP 5X5 AgCu Post	8	32.97	4.56	20.84	25.55	39.15
HDSS@270 5X5 AgCu PMB	8	9.983	0.827	0.684	9.138	11.265
HDSS@270 5X5 AgCu PM5	8	8.099	1.247	1.555	5.814	9.636
HDSS@270 5X5 AgCu PPB	8	2.371	1.091	1.191	1.149	4.122

8 x 8-mm

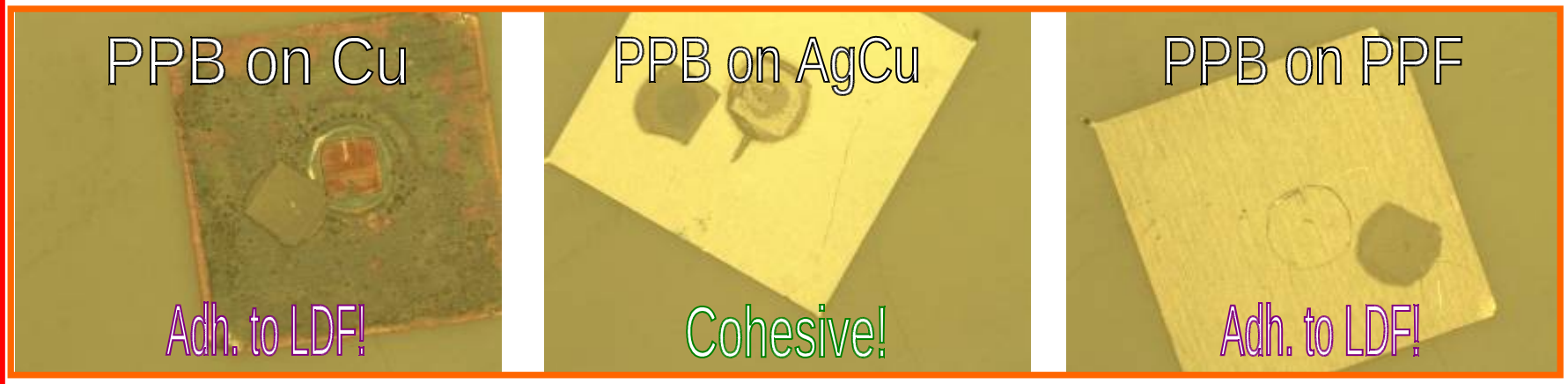
ROOM TEMP 8X8 AgCu Post	8	53.499	1.624	2.637	51.233	55.535
HDSS@270 8X8 AgCu PMB	8	28.849	1.943	3.776	26.013	31.046
HDSS@270 8X8 AgCu PM5	8	21.71	4.25	18.06	15.39	28.80
HDSS@270 8X8 AgCu PPB	8	9.42	3.54	12.50	3.95	14.31

Die Shear Failure Mode

- The following die shear failures were observed at the 2 x 2-mm die size after cure and post mold bake: -

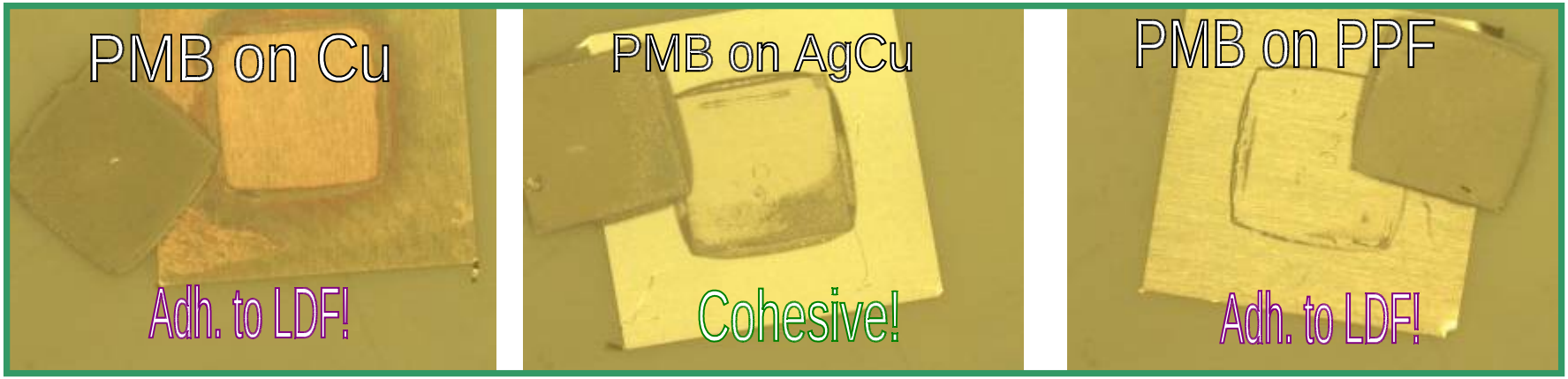
Die Shear Failure Mode

- The following die shear failures were observed at the 2 x 2-mm die size after PM5 and PPB bake: -



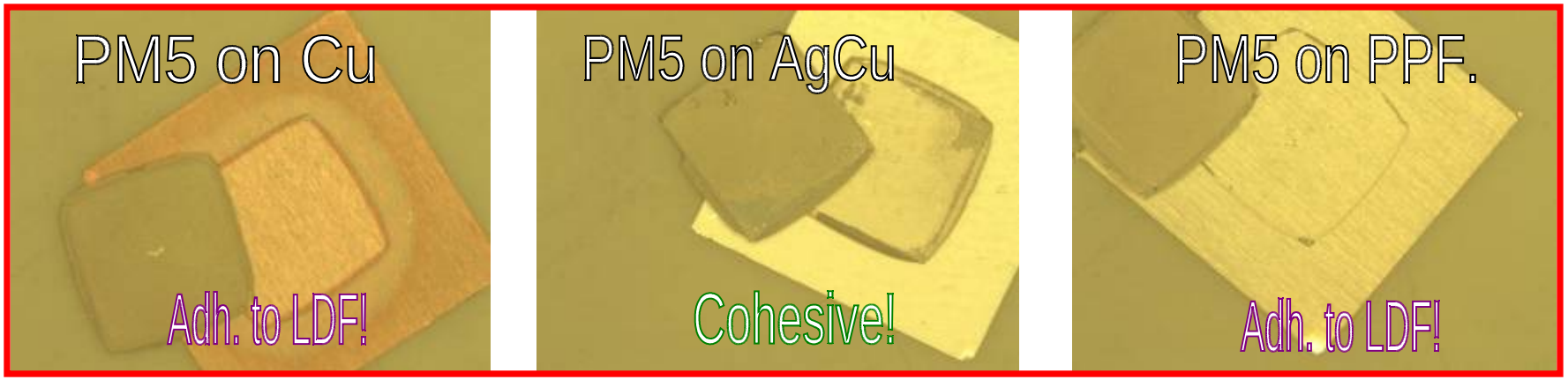
Die Shear Failure Mode

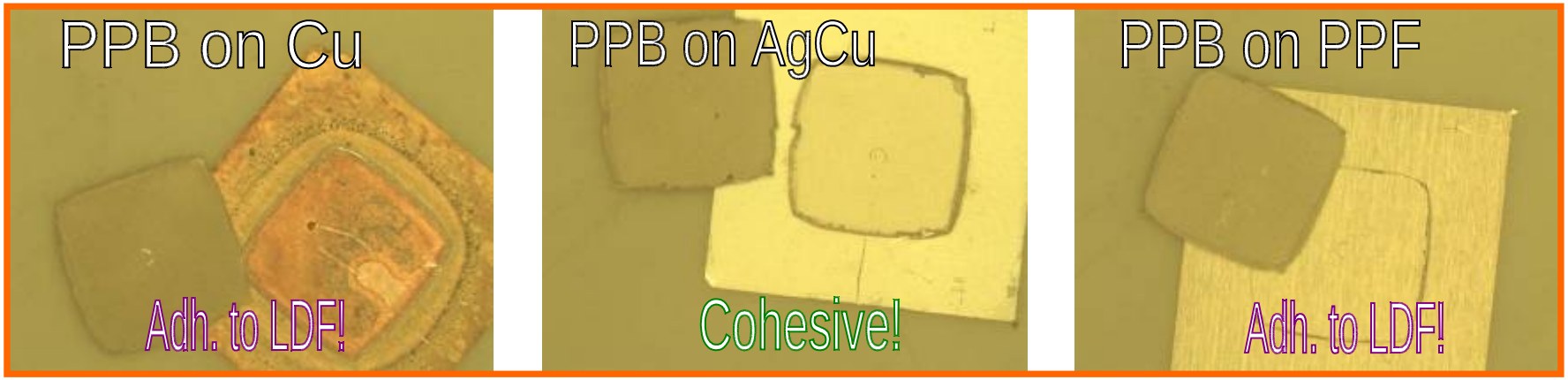
- The following die shear failures were observed at the 5 x 5-mm die size after cure and post mold bake: -



Die Shear Failure Mode

- The following die shear failures were observed at the 5 x 5-mm die size after PM5 and PPB bake: -





Die Shear Failure Mode

- The following die shear failures were observed at the 8 x 8-mm die size after cure and post mold bake: -

Die Shear Failure Mode

- The following die shear failures were observed at the 8 x 8-mm die size after PM5 and PPB bake: -

Adhesion Comparison on Cu LDF

- **The Adhesion data obtained was converted into g/mm² and compared against other products from with the Henkel portfolio: -**

Mean Adhesion Strength Data in g/mm² For 8491, FS849-TI, 84-1LMISR8 and QMI529HT on Cu LDF					
Die Size (mm)	Conditioning	8491 (g/mm²)	FS849-TI (g/mm²)	84-1LMISR8 (g/mm²)	QMI529HT (g/mm²)
2 x 2	Post Mold Bake (270°C)	417	390.7	341.7	152.0
	PM5 (270°C)	316	353.5	324.2	98
	PPB (270°C)	224.5	345.2	277.2	72
5 x 5	Post Mold Bake (270°C)	439	26.6	208.4	66
	PM5 (270°C)	124.2	59.8	142.2	36
	PPB (270°C)	137.5	37.0	131.4	27
8 x 8	Post Mold Bake (270°C)	364.0	26.4	179.6	52
	PM5 (270°C)	221.2	12.8	102.6	10
	PPB (270°C)	174.5	18.5	80.5	8

Adhesion Comparison on PPF LDF

- **The Adhesion data obtained was converted into g/mm² and compared against other products from with the Henkel portfolio: -**

Mean Adhesion Strength Data in g/mm² For 8491, FS849-TI, 84-1LMISR8 and QMI529HT on PPF LDF					
Die Size (mm)	Conditioning	8491 (g/mm²)	FS849-TI (g/mm²)	84-1LMISR8 (g/mm²)	QMI529HT (g/mm²)
2 x 2	Post Mold Bake (270°C)	486.2	406	251.7	344.7
	PM5 (270°C)	422.7	454.5	282.2	451.5
	PPB (270°C)	172.7	411.2	211.5	170.9
5 x 5	Post Mold Bake (270°C)	307.3	350.4	116.1	230.2
	PM5 (270°C)	343.0	231.1	114.4	118.0
	PPB (270°C)	303.8	214.2	71.6	44.6
8 x 8	Post Mold Bake (270°C)	216.6	284.3	54.8	395.7
	PM5 (270°C)	237.9	23.14	59.7	263.8
	PPB (270°C)	307.5	53.37	44.0	185.8

Adhesion Comparison on AgCu LDF

- **The Adhesion data obtained was converted into g/mm² and compared against other products from with the Henkel portfolio: -**

Mean Adhesion Strength Data in g/mm² For 8491, FS849-TI, 84-1LMISR8 and QMI529HT on AgCu LDF					
Die Size (mm)	Conditioning	8491 (g/mm²)	FS849-TI (g/mm²)	84-1LMISR8 (g/mm²)	QMI529HT (g/mm²)
2 x 2	Post Mold Bake (270°C)	348	661.5	368.7	465.0
	PM5 (270°C)	303.2	587.7	214.2	639.2
	PPB (270°C)	212.6	433.2	220.2	303.8
5 x 5	Post Mold Bake (270°C)	413.8	268.3	191.0	399.3
	PM5 (270°C)	412	104.9	124.8	323.9
	PPB (270°C)	285.7	112.7	84.7	94.8
8 x 8	Post Mold Bake (270°C)	383.3	116.1	93.5	450.7
	PM5 (270°C)	308.2	48.3	60.8	339.2
	PPB (270°C)	303.7	20.7	55.5	147.1

Conclusions

- QMI529HT does not perform well and should not be recommended for copper surfaces.

- QMI529HT sticks well to PPF leadframes however as the test conditions become more stringent the failure mode becomes more adhesive than cohesive.

- QMI529HT sticks well to AgCu leadframe surfaces and retains a cohesive failure mode irrespective of die size and test condition.

Recommendation

- QMI529HT can be considered for leadframe packages using PPF (NiPdAu) and AgCu.

Conductive Dot Dispense Comparison.

Background

- QMI529HT and QMI519 are widely used conductor die attach adhesives. It is necessary to characterise the dispense performance of these two adhesives in a dot dispense test.

- The above materials will be compared against Ablebond 8290 & 84-1LMISR4 which are considered the industry standard in terms of dispensability.

- Additionally the performance will be compared against Ablebond 8491 which is another adhesive used in the same packages as QMI529HT and QMI519.

Experimental

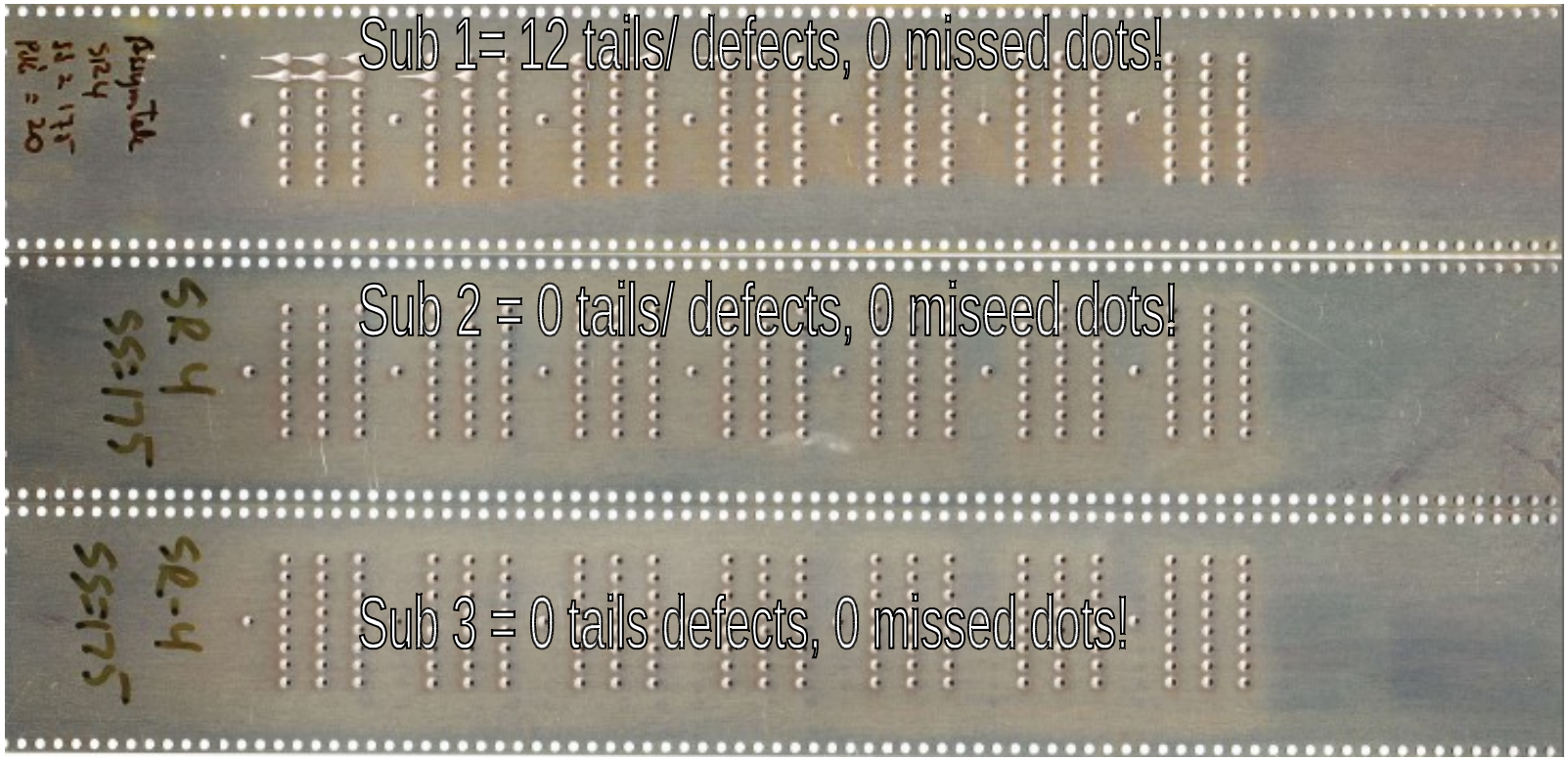
- Dot Dispense
  - **A standard dot dispense trial was performed to try and assess if there is any deterioration in the product dispense performance.**
  - **After selecting the appropriate shot size the dispense test method is performed by dispensing adjacent dots in three consecutive rows using defined dispense conditions, before moving to next set of three dots using another condition: -**

Dispense Needle:	0.4-mm diameter (EFD Blue 16”).
Dispense Pressure:	30 psi.
Dispense Time:	125 m/sec.
Dispense Height:	0.25-mm.
Dispense ‘Move Up’ Height:	Varied – 350, 300, 250, 200, 150, 100 & 50 (mil).

  - **Three test frames were produced per adhesive and dispense defects counted.**
  - **The final comparative analysis was done using a ‘Two Proportions Test’ of the adhesive in question versus the control.**

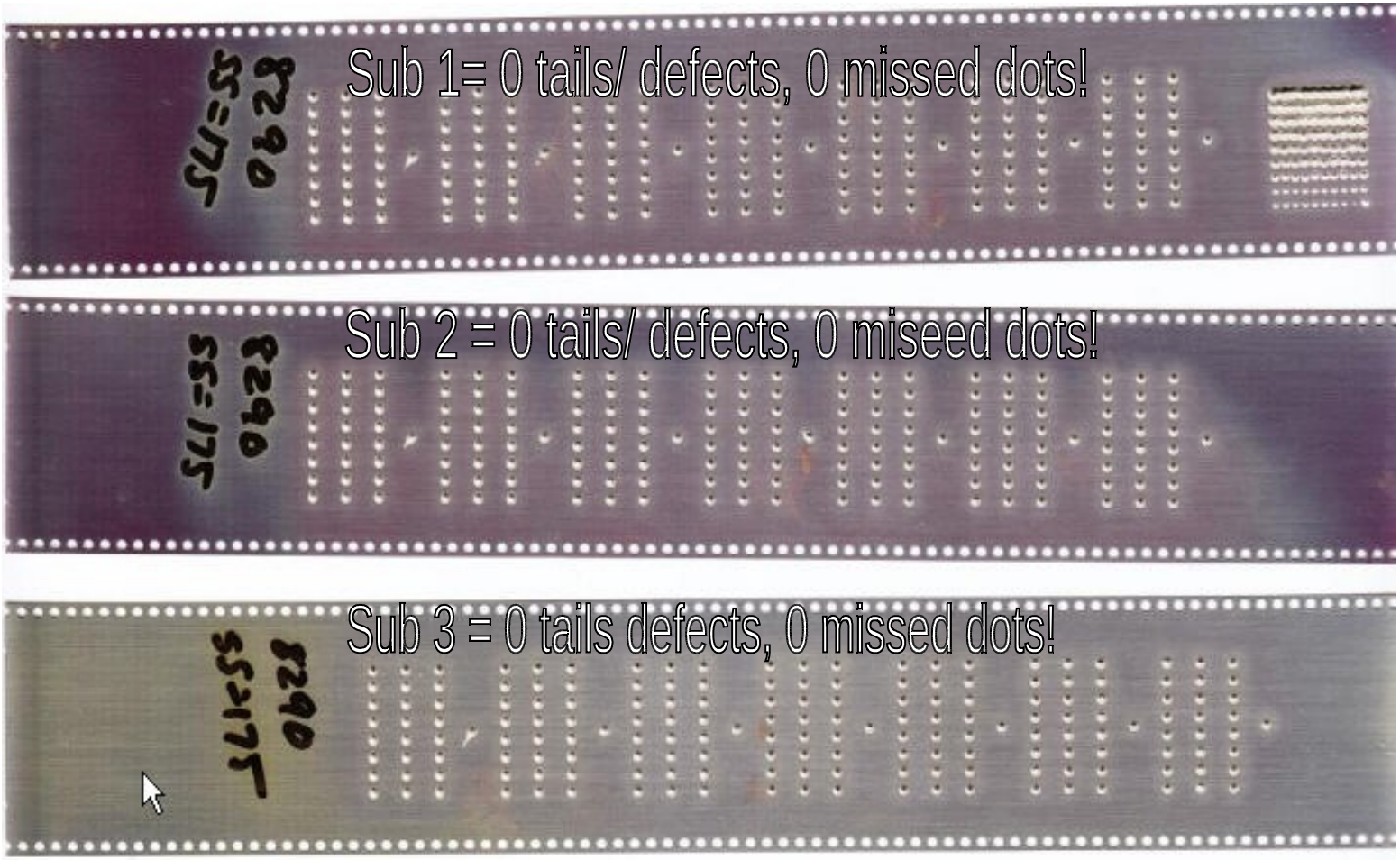
Dot Dispense Result

- **Ablebond 84-1LMISR4 (Control 1)**



Dot Dispense Result

- **Ablebond 8290 (Control)**



2 Proportions Test - SR4 versus 8290

- **A two proportions test was performed on the two control materials: -**
  - **SR4 - 12 Defects out of 504 Trials.**
  - **8290 – 0 Defects out of 504 Trials.**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	12	504	0.023810
2	0	504	0.000000

Difference = p (1) - p (2)
Estimate for difference: 0.0238095
95% CI for difference: (0.0104996, 0.0371194)
Test for difference = 0 (vs not = 0): Z = 3.51 P-Value = 0.000

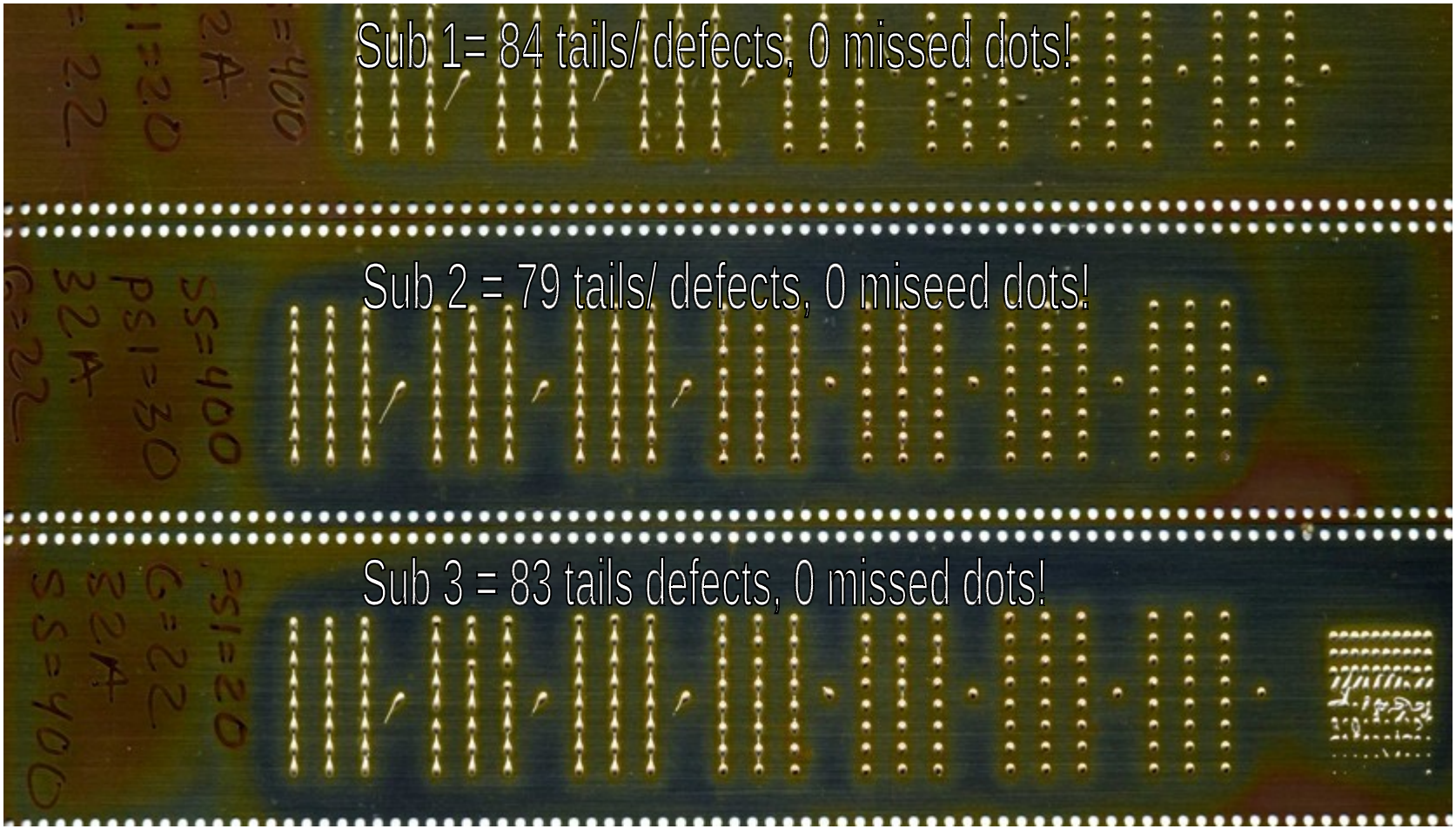
Fisher's exact test: P-Value = 0.000

When the two control materials are compared against each other we can see that in this trial Ablebond 84-1LMISR4 has statistically worse dispense performance versus Ablebond 8290 (95% CI).

NB. 2-Proportions: computes a confidence interval and performs a hypothesis test of the difference between two population proportions

Dot Dispense Result

- **Ablebond 8491**



Two Proportions Test For 8491 versus SR4 & 8290.

- **SR4 v 8491**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	12	504	0.023810
2	246	504	0.488095

Difference = p (1) - p (2)
Estimate for difference: -0.464286
95% CI for difference: (-0.509910, -0.418662)
Test for difference = 0 (vs not = 0): Z = -19.95 P-Value = 0.000

Fisher's exact test: P-Value = 0.000

- **8290 v 8491**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	0	504	0.000000
2	246	504	0.488095

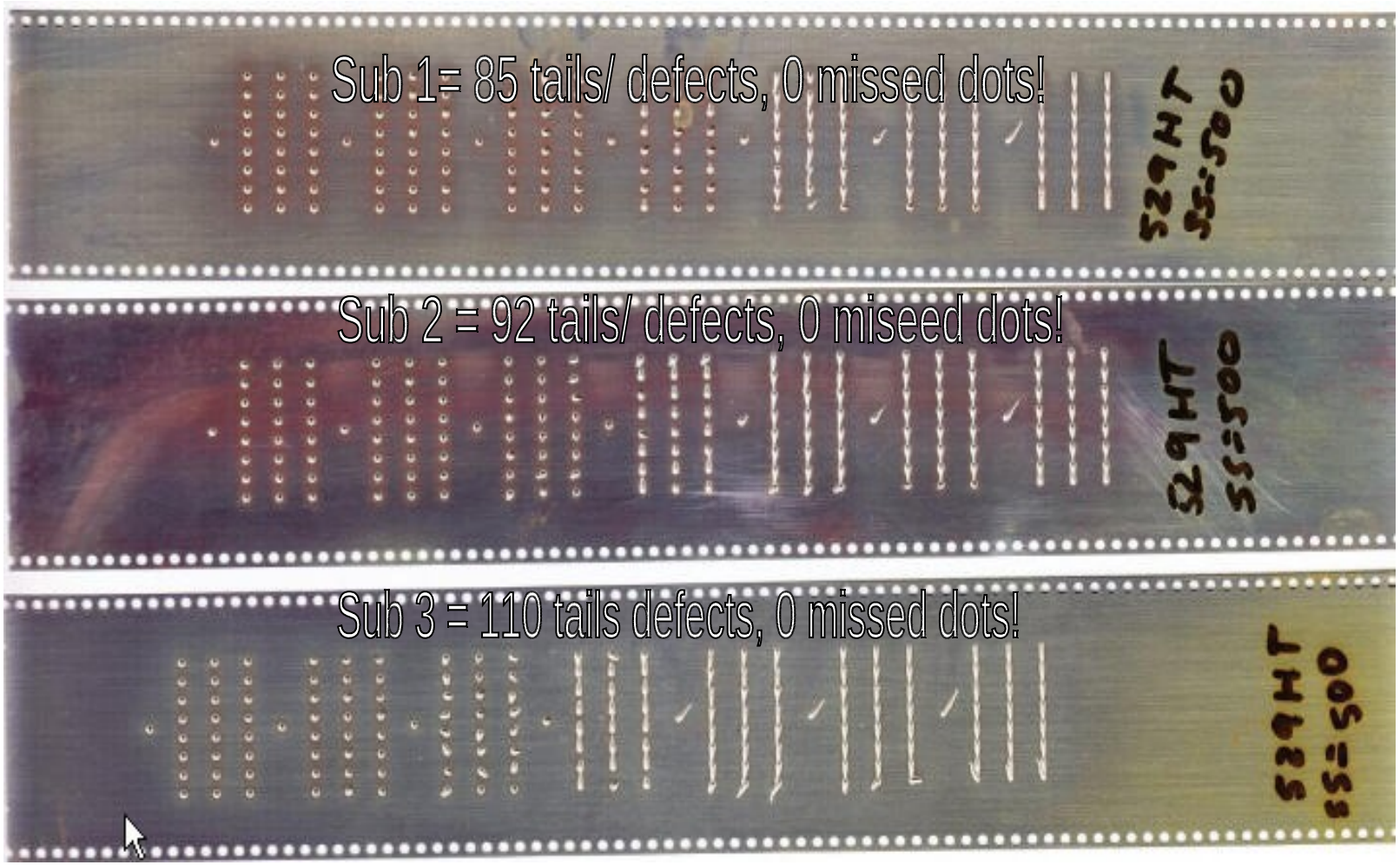
Difference = p (1) - p (2)
Estimate for difference: -0.488095
95% CI for difference: (-0.531735, -0.444456)
Test for difference = 0 (vs not = 0): Z = -21.92 P-Value = 0.000

Fisher's exact test: P-Value = 0.000

Both control materials have statistically superior dispense performance versus 8491 in this test.

Dot Dispense Result

- **QMI529HT**



Two Proportions Test For QMI529HT versus SR4 & 8290.

- **SR4 v QMI529HT**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	12	504	0.023810
2	287	504	0.569444

Difference = p (1) - p (2)
Estimate for difference: -0.545635
95% CI for difference: (-0.590866, -0.500403)
Test for difference = 0 (vs not = 0): Z = -23.64 P-Value = 0.000

Fisher's exact test: P-Value = 0.000

- **8290 v QMI529HT**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	0	504	0.000000
2	287	504	0.569444

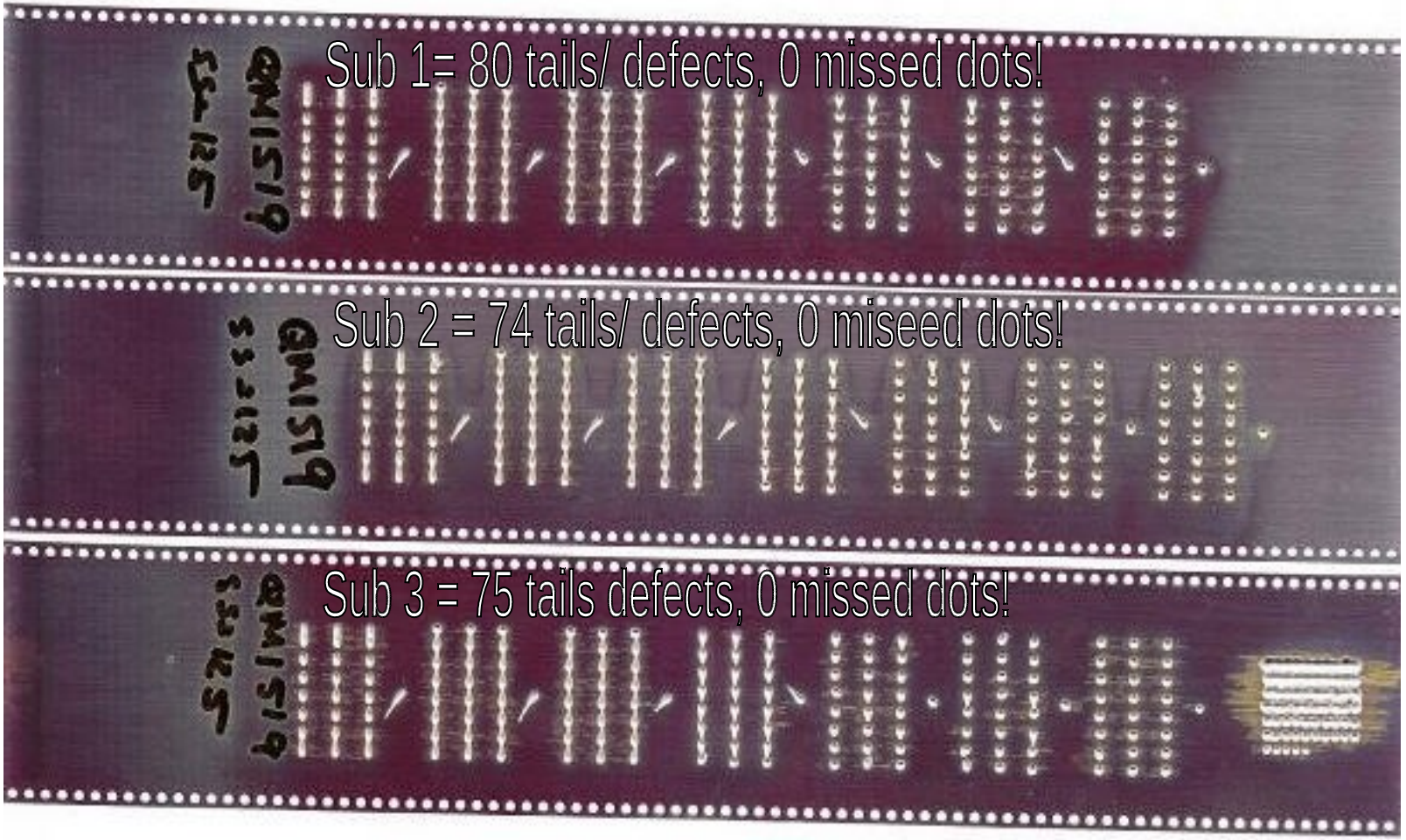
Difference = p (1) - p (2)
Estimate for difference: -0.569444
95% CI for difference: (-0.612673, -0.526216)
Test for difference = 0 (vs not = 0): Z = -25.82 P-Value = 0.000

Fisher's exact test: P-Value = 0.000

Both control materials have statistically superior dispense performance versus QMI529HT in this test.

Dot Dispense Result

- **QMI519**



Two Proportions Test For QMI519 versus SR4 & 8290.

- **SR4 v QMI519**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	12	504	0.023810
2	229	504	0.454365

Difference = p (1) - p (2)
Estimate for difference: -0.430556
95% CI for difference: (-0.476017, -0.385094)
Test for difference = 0 (vs not = 0): Z = -18.56 P-Value = 0.000

Fisher's exact test: P-Value = 0.000

- **8290 v QMI519**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	0	504	0.000000
2	229	504	0.454365

Difference = p (1) - p (2)
Estimate for difference: -0.454365
95% CI for difference: (-0.497835, -0.410895)
Test for difference = 0 (vs not = 0): Z = -20.49 P-Value = 0.000

Fisher's exact test: P-Value = 0.000

Both control materials have statistically superior dispense performance versus QMI529HT in this test.

Two Proportions Test For 8491 versus QMI519 & QMI529HT.

- **8491 v QMI519**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	246	504	0.488095
2	229	504	0.454365

Difference = p (1) - p (2)
Estimate for difference: 0.0337302
95% CI for difference: (-0.0278654, 0.0953258)
Test for difference = 0 (vs not = 0): Z = 1.07 P-Value = 0.283
Fisher's exact test: P-Value = 0.313

QMI519 and 8491 statistically equivalent in terms of dispense performance (95% CI).

- **8491 v QMI529HT**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	246	504	0.488095
2	287	504	0.569444

Difference = p (1) - p (2)
Estimate for difference: -0.0813492
95% CI for difference: (-0.142775, -0.0199234)
Test for difference = 0 (vs not = 0): Z = -2.60 P-Value = 0.009

Fisher's exact test: P-Value = 0.012

8491 statistically better in terms of dispensing compared with QMI529HT.

8491 v QMI529HT & QMI519

- **QMI529HT v QMI519**

Test and CI for Two Proportions

Sample	X	N	Sample p
1	229	504	0.454365
2	287	504	0.569444

Difference = p (1) - p (2)
Estimate for difference: -0.115079
95% CI for difference: (-0.176385, -0.0537741)
Test for difference = 0 (vs not = 0): Z = -3.68 P-Value = 0.000

Fisher's exact test: P-Value = 0.000

QMI519 statistically better than QMI529HT in terms of its dispense performance.

Conclusions

- **All test adhesives have statistically inferior dispense performance when compared versus the industry standard dispensing paste, 8290 and 84-1LMISR4.**
- **QMI519 and 8491 have statistically equivalent dispense performance.**
- **QMI529HT has statistically inferior dispense performance compared to both QMI519 and 8491.**

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Resin Bleed Comparison for QMI529HT and QMI519 versus other Selected Conductive Adhesives.

Background

- **QMI529HT and QMI519 are widely used conductor die attach adhesives. It is necessary to characterise the resin bleed performance.**

- **The above materials will be compared against Ablebond 8290 & 84-1LMISR4 which are two commonly recognised, industry standard die attach adhesives.**

Experimental

- **Resin Bleed:**
  - **The thawed adhesive was dot dispensed onto the test leadframes surface(s), Cu, AgCu, NiPdAu.**
  - **The diameter of the dots was measured. Subsequently the adhesive dot size, including any bleed, was re-measured after defined time intervals at ambient conditions (T = 0, 2, Hrs).**
  - **The adhesive dots were cured using the recommended cure profile and the adhesive dot size re-measured.**
  - **The mean %age bleed was calculated and the batches compared.**

Results

- **The Following basics statistics for resin bleed (% increase) were obtained for the 4 test products on the different surfaces: -**

Cu Leadframe

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
8290 Cu T =2 Hrs	7	0.490	0.650	0.423	0.000	1.390
8290 Cu T = PC	7	0.490	0.650	0.423	0.000	1.390
SR4 Cu T =2 Hrs	7	4.81	3.00	9.02	0.64	7.95
SR4 Cu T = PC	7	4.81	3.00	9.02	0.64	7.95
QMI529HT Cu T =2 Hrs	7	0.451	0.498	0.248	0.000	1.210
QMI529HT Cu T = PC	7	0.451	0.498	0.248	0.000	1.210
QMI519 Cu T = 2Hrs	7	3.322	2.229	4.969	0.087	5.930
QMI519 Cu T = PC	7	3.322	2.229	4.969	0.087	5.930

AgCu Leadframe

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
8290 AgCu T =2 Hrs	7	0.376	0.520	0.270	0.000	1.210
8290 AgCu T = PC	7	0.376	0.520	0.270	0.000	1.210
SR4 AgCu T =2 Hrs	7	7.86	4.55	20.70	1.24	12.22
SR4 AgCu T = PC	7	7.86	4.55	20.70	1.24	12.22
QMI529HT AgCu T =2 Hrs	7	47.87	7.24	52.45	40.50	57.94
QMI529HT AgCu T = PC	7	56.77	6.20	38.40	50.85	67.27
QMI519 AgCu T = 2Hrs	7	15.799	2.413	5.823	12.970	19.760
QMI519 AgCu T = PC	7	42.10	14.78	218.34	21.47	68.86

Results

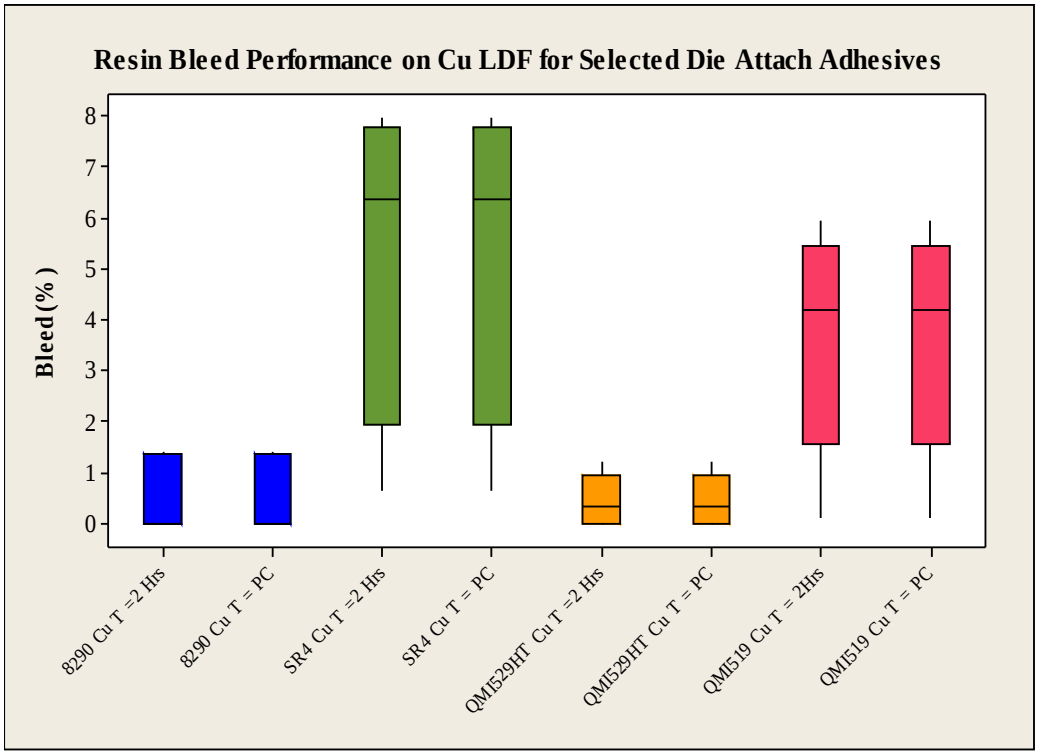
- **The Following basics statistics for resin bleed (% increase) were obtained for the 4 test products on the different surfaces: -**

PPF Leadframe

Variable	Total Count	Mean	StDev	Variance	Minimum	Maximum
8290 PPF T =2 Hrs	7	6.25	7.64	58.38	0.00	22.56
8290 PPF T = PC	7	6.95	7.33	53.69	0.00	22.56
SR4 PPF T =2 Hrs	7	12.214	2.191	4.802	10.040	15.860
SR4 PPF T = PC	7	16.59	4.17	17.40	10.46	22.17
QMI529HT PPF T =2 Hrs	7	40.63	13.02	169.40	29.75	67.27
QMI529HT PPF T = PC	7	49.13	10.98	120.58	34.68	67.27
QMI519 PPF T = 2Hrs	7	23.92	3.81	14.54	19.78	31.68
QMI519 PPF T = PC	7	54.07	8.02	64.34	41.21	64.25

Results

- **The results can be further viewed using a Box plot and ANOVA analysis on Cu Leadframe: -**



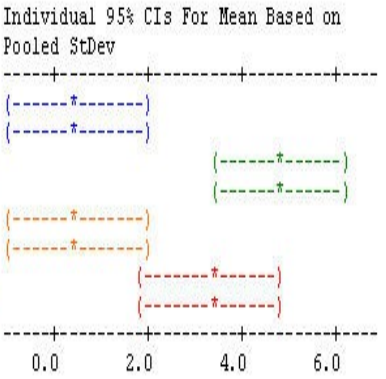
ANOVA Analysis on Cu LDF

Source	DF	SS	MS	F	P
Factor	7	196.39	28.06	7.66	0.000
Error	48	175.90	3.66		
Total	55	372.29			

S = 1.914 R-Sq = 52.75% R-Sq(adj) = 45.86%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev
8290 Cu T =2 Hrs	7	0.490	0.650
8290 Cu T = PC	7	0.490	0.650
SR4 Cu T =2 Hrs	7	4.809	3.003
SR4 Cu T = PC	7	4.809	3.003
QMI529HT Cu T =2 Hrs	7	0.451	0.498
QMI529HT Cu T = PC	7	0.451	0.498
QMI519 Cu T = 2Hrs	7	3.322	2.229
QMI519 Cu T = PC	7	3.322	2.229

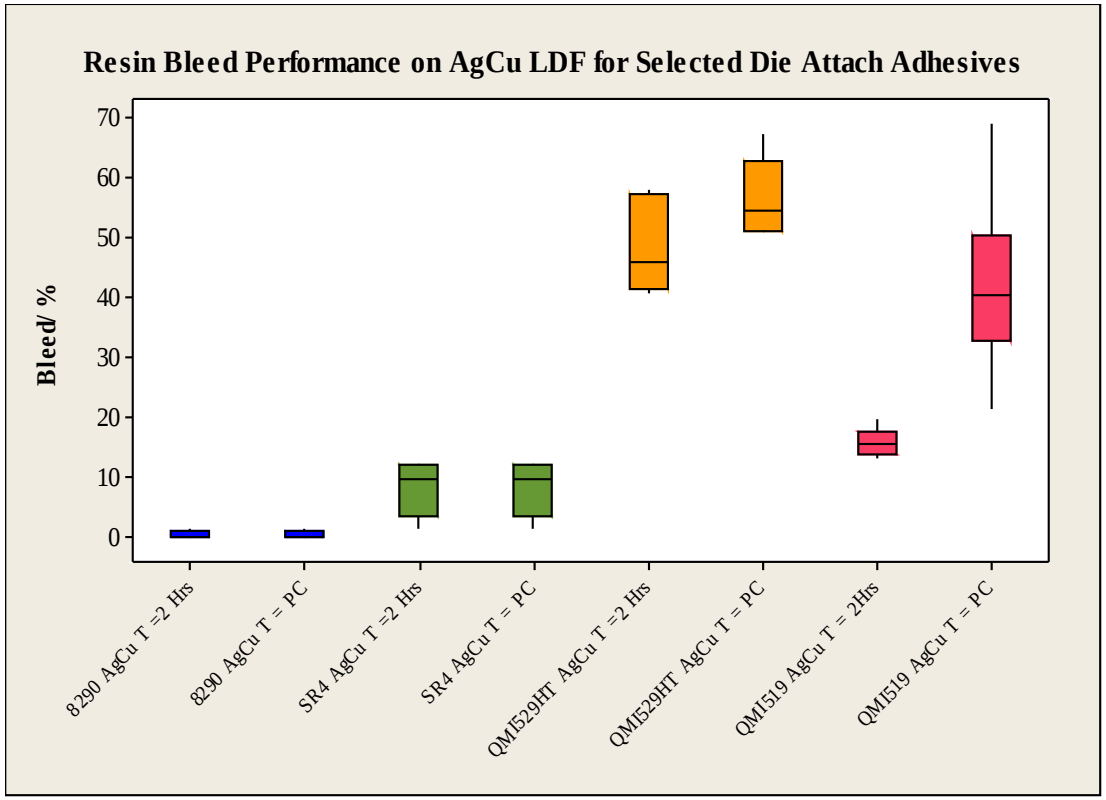


Pooled StDev = 1.914

Minimal to zero resin bleed on Cu leadframe for all test adhesives!

Results

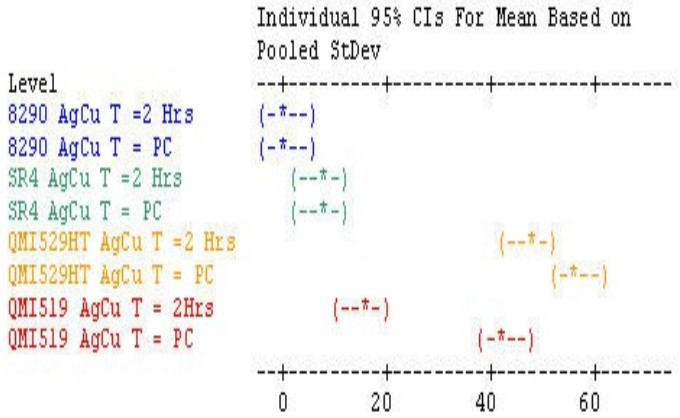
- **The results can be further viewed using a Box plot and ANOVA analysis on AgCu Leadframe: -**



ANOVA Analysis on AgCu LDF

Source	DF	SS	MS	F	P
Factor	7	25586.4	3655.2	81.92	0.000
Error	48	2141.7	44.6		
Total	55	27728.1			

S = 6.680 R-Sq = 92.28% R-Sq(adj) = 91.15%

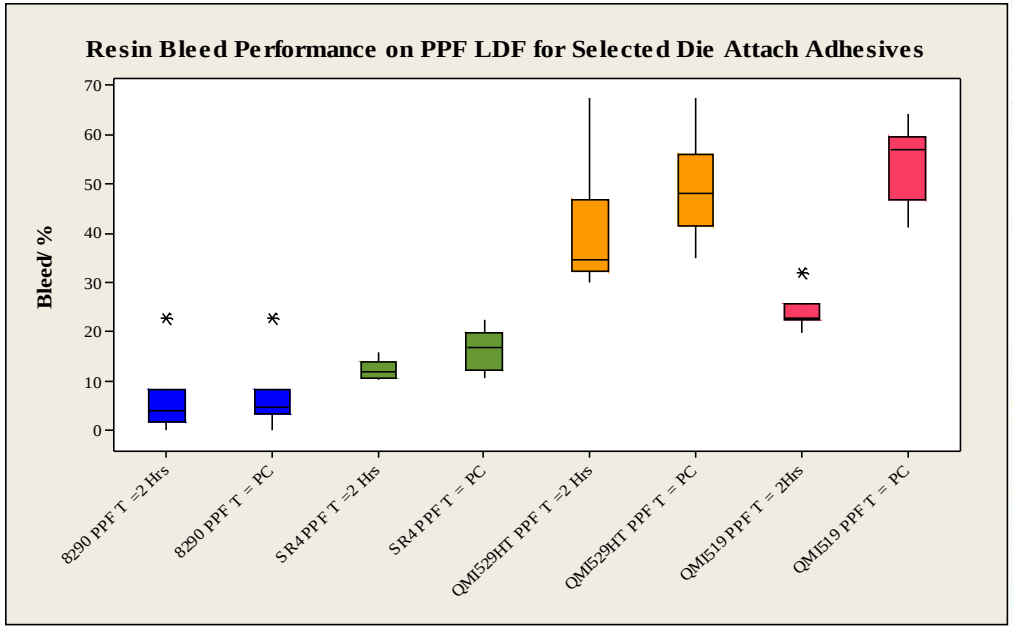


Pooled StDev = 6.680

QMI519 & QMI529HT exhibit greater bleed on AgCu leadframe than the control test adhesives!

Results

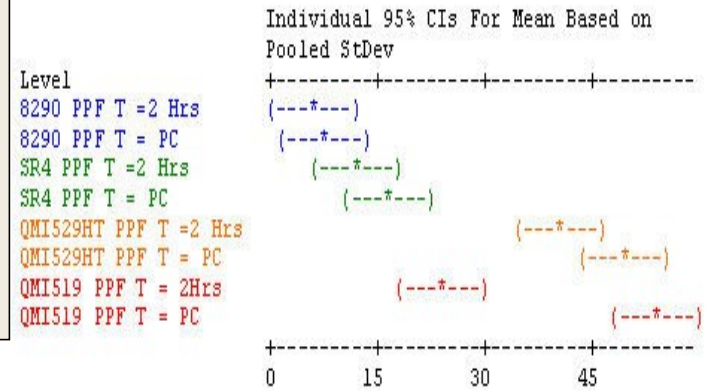
- **The results can be further viewed using a Box plot and ANOVA analysis on PPF Leadframe: -**



ANOVA Analysis on PPF LDF

Source	DF	SS	MS	F	P
Factor	7	18005.9	2572.3	40.90	0.000
Error	48	3018.8	62.9		
Total	55	21024.7			

S = 7.930 R-Sq = 85.64% R-Sq(adj) = 83.55%

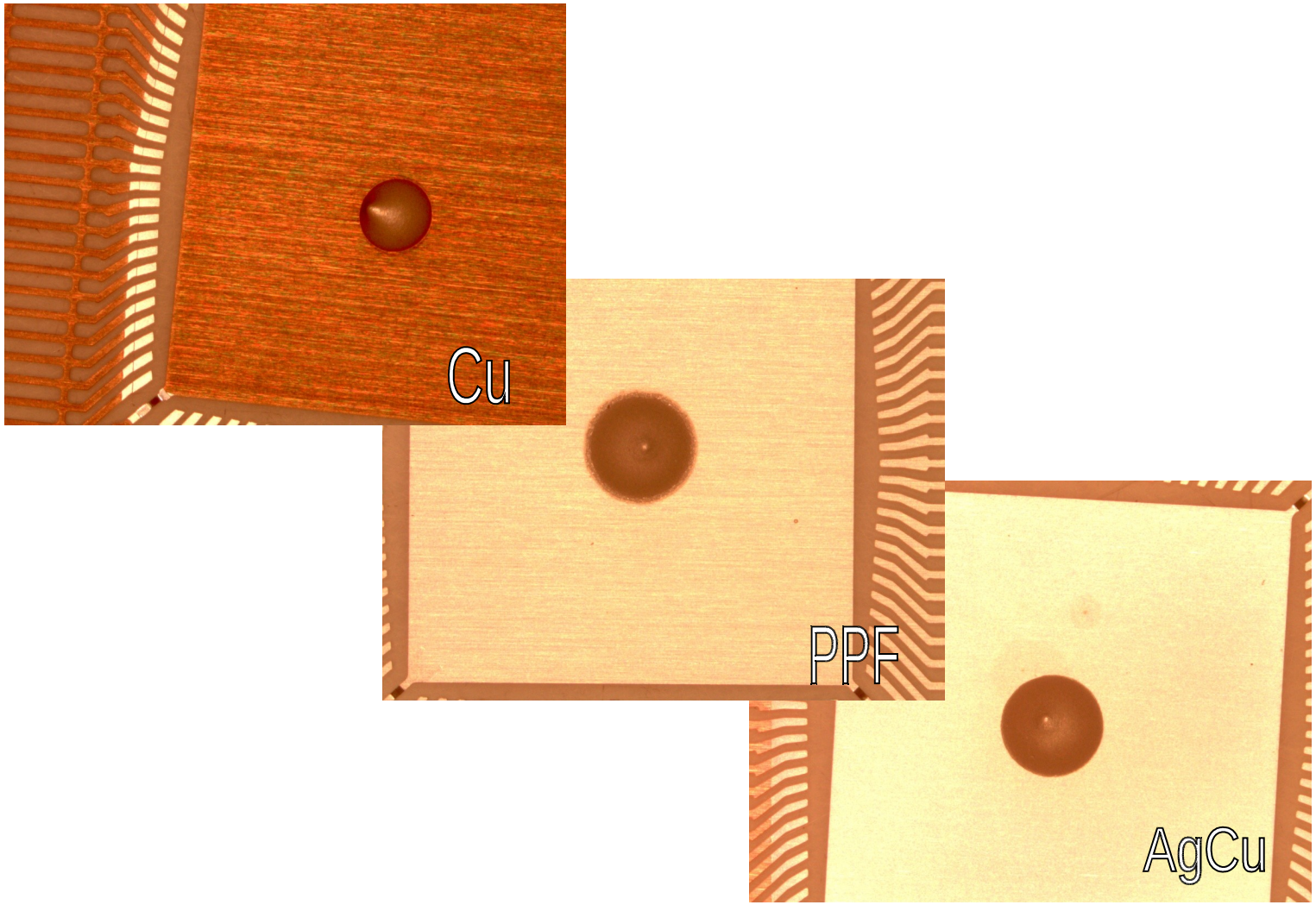


Pooled StDev = 7.930

QMI519 & QMI529HT exhibit greater bleed on PPF leadframe than the control test adhesives!

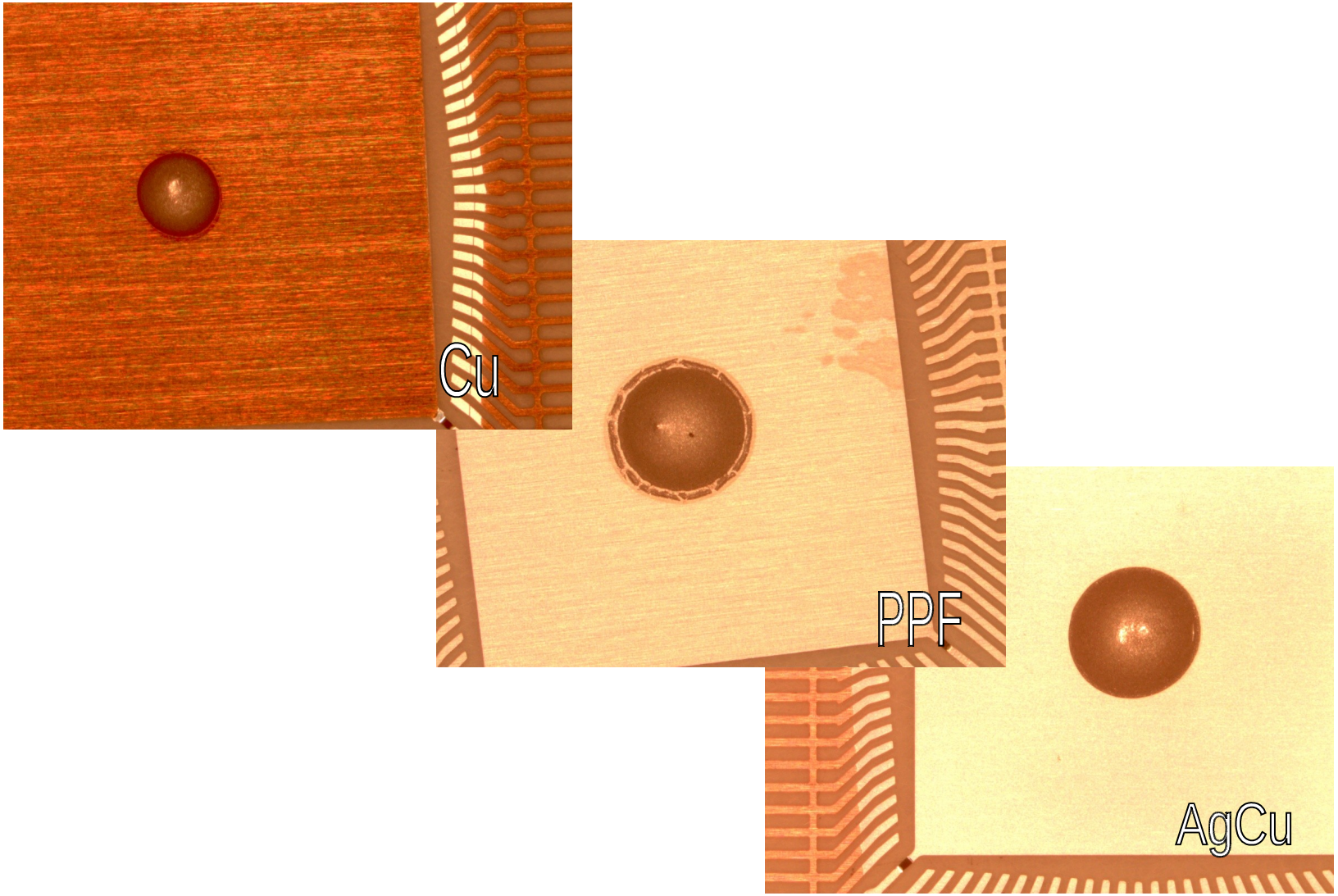
Results

- 8290



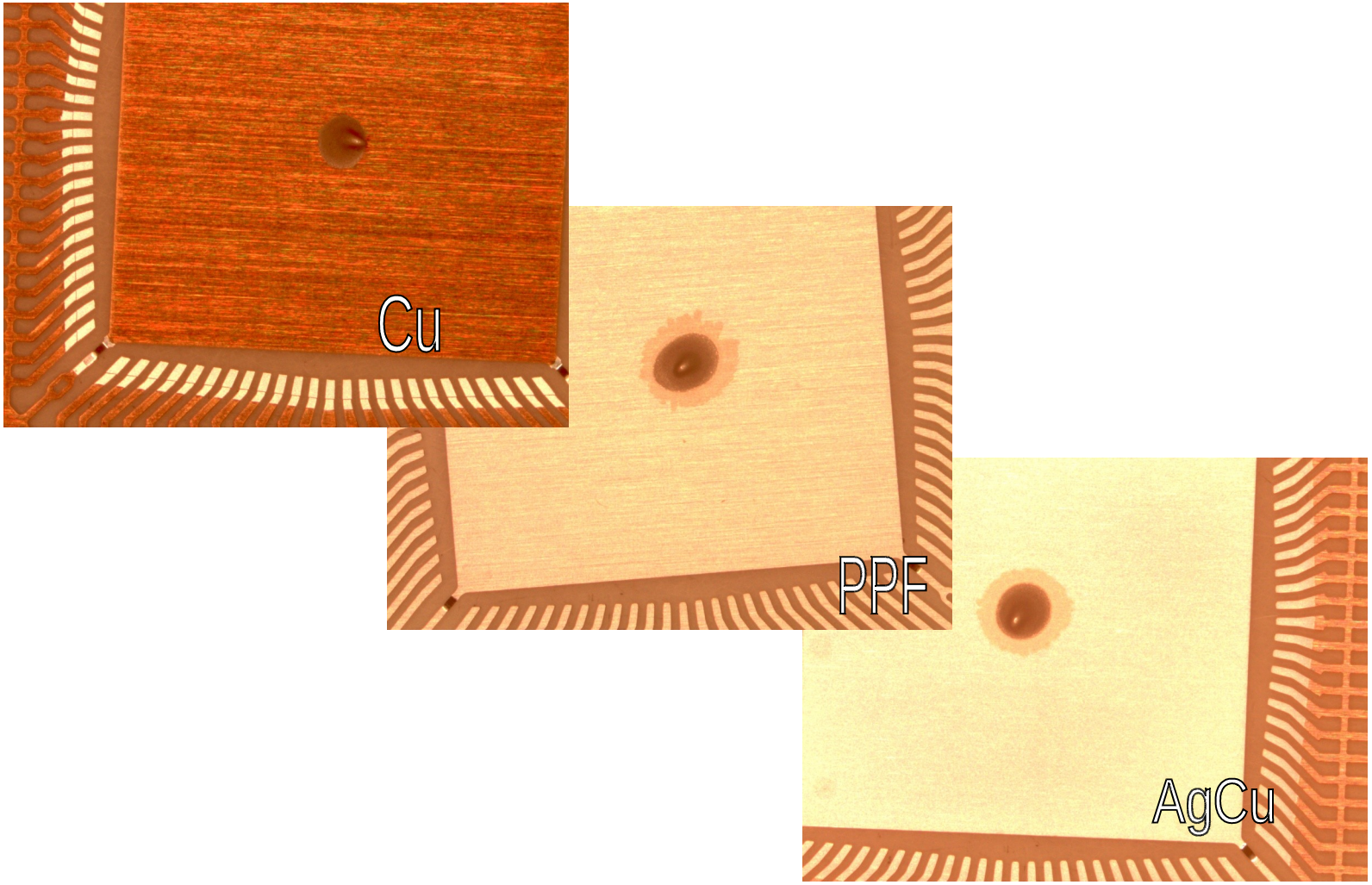
Results

- **84-1LMISR4**



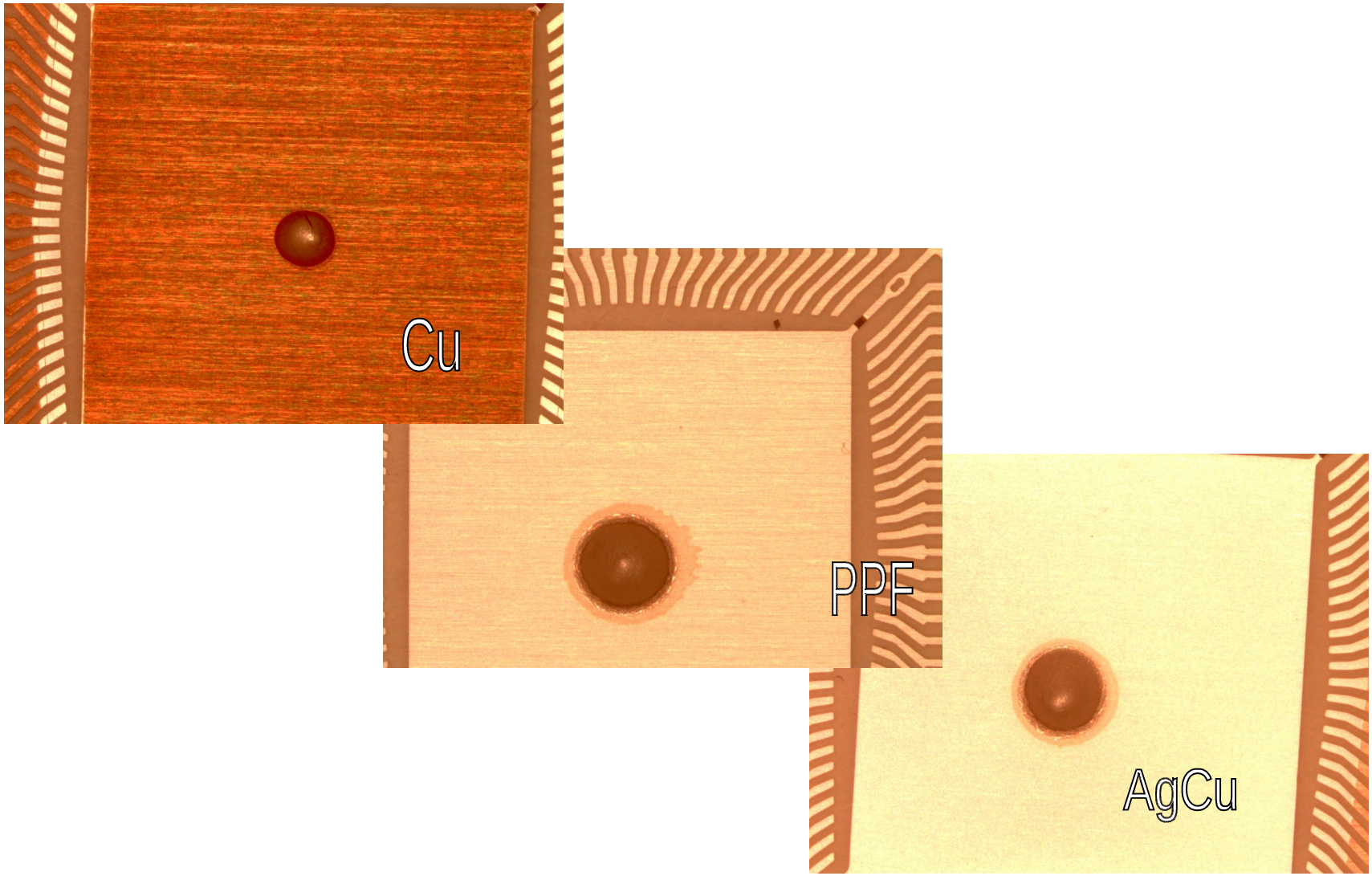
Results

- **QMI529HT**



Results

- **QMI519**



Conclusions/ Comments

- **There is no significant bleed on Cu leadframe for any of the test materials.**
- **QMI519 & QMI529HT both exhibit statistically higher resin bleed on AgCu and PPF surfaces than the control materials used in this evaluation.**

- **Resin bleed as a phenomena is very much surface dependant. Different products typically perform differently depending on the surface used, as such this work gives a comparative view of the possible performance but it should not be considered definitive. Resin bleed should always before verified on the target substrate before ruling in or out any adhesive candidate.**

Freezing Point & Storage Handling of QMI529HT.

Outline

- Introduction – how the freezing point effects on FTV
- Freezing point data of Ablebond 3230 and recommended storage temperature
- Appendix A : Other factors effecting on FTV
- Appendix B : Handling recommendations
- Appendix C : Freezing point curves

Introduction

- **The FTV potential of an adhesive is significantly affected by its freezing point, storage temperature and shipping temperature. Testing has shown that an adhesive must be frozen in order for delamination to occur (between the frozen adhesive and syringe wall) and cause FTVs**
- **A frozen adhesive is incapable of absorbing stresses resulting from differential shrinkage/expansion of the adhesive, syringe and piston. As the syringe temperature is reduced farther below its freezing point, more and more stress is created to the point where delamination occurs during thaw (thermal shock) which will ultimately lead to FTVs**
- **Since the freezing point of each adhesive is unique, specific storage/handling/shipping recommendations may need to be made for high freezing point adhesives.**

Source: ***FTV Presentation by Derek Wyatt (Tech Serv Dept-Version 1.5)***

Factors Effecting FTVs

A) Adhesive Freezing Point

B) Piston Effects

- Proximity to adhesive
- Design Geometry

C) Syringe Size

D) Handling (Covered later)

Main objective for this study

What Is A Freezing Point?

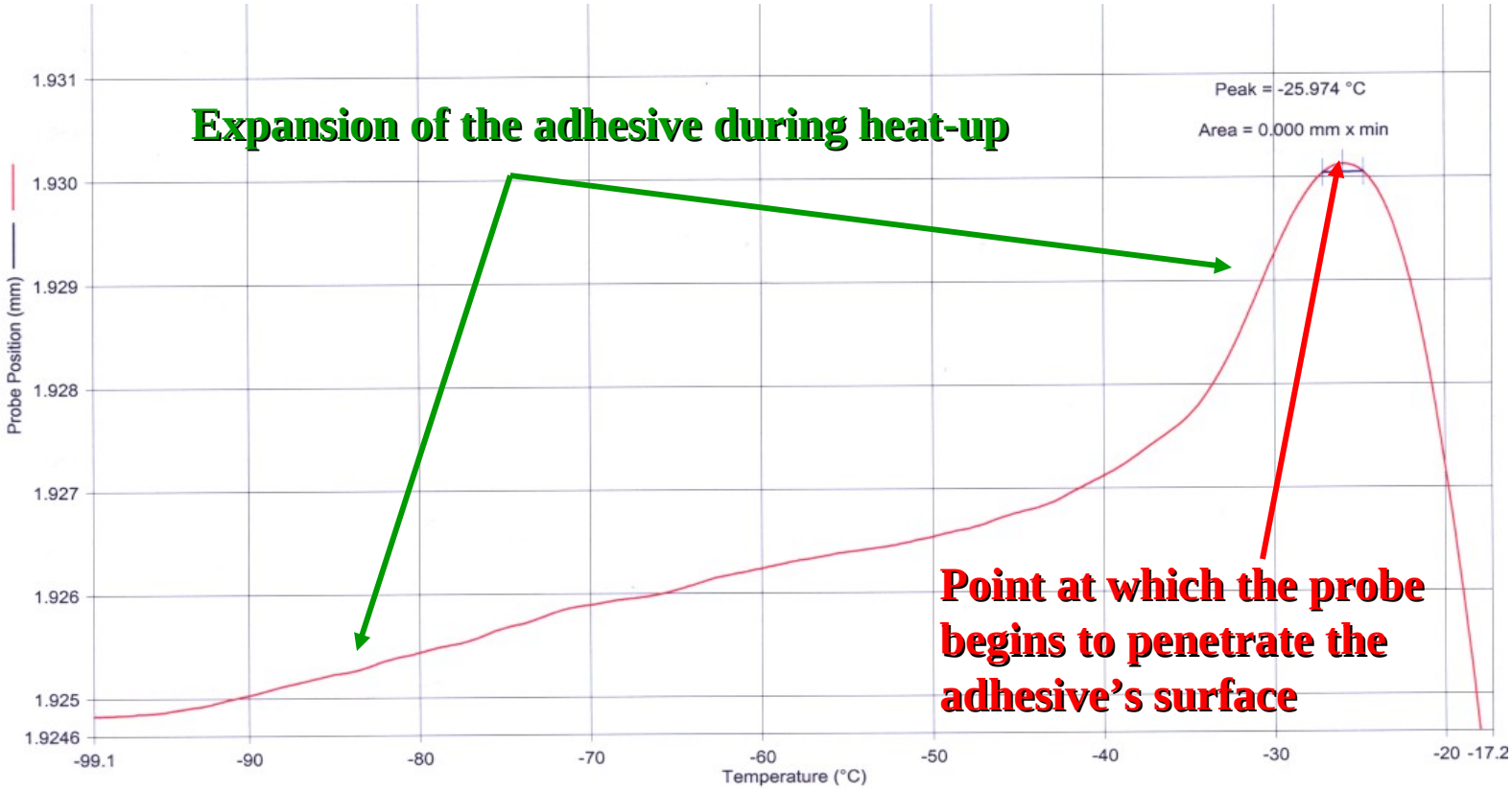
By Definition, the freezing point of a liquid is:

"The temperature at which the liquid and solid phases of a substance of specified composition are in equilibrium at atmospheric pressure".

Since most of Ablestik's adhesives are complex mixtures and that it is highly unlikely that they would have a true freezing point (by definition), the freezing point will be considered to be the temperature at which the adhesive takes on similar characteristics of a solid and has a tack-free surface.

Source: *The American Heritage® Dictionary of the English Language, Fourth Edition*

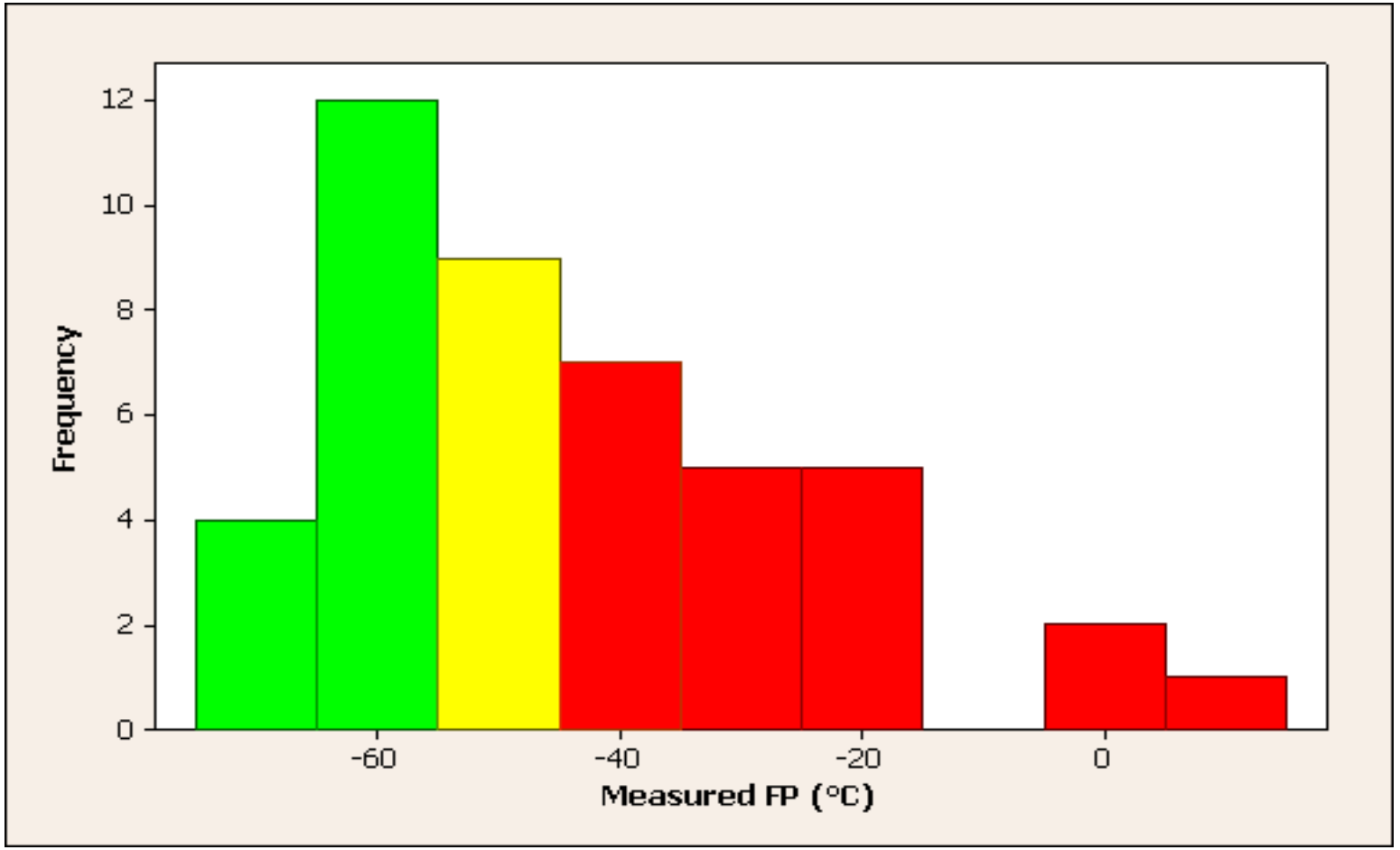
How Is The Freezing Point Measured?



Using TMA (fitted with an expansion probe), the probe position is monitored while increasing the sample temperature. The point at which the probe begins to penetrate the sample is considered the freezing point of the adhesive.

Note: TMA used instead of DSC due to complexity of an adhesive and its affects on the measured endotherms.

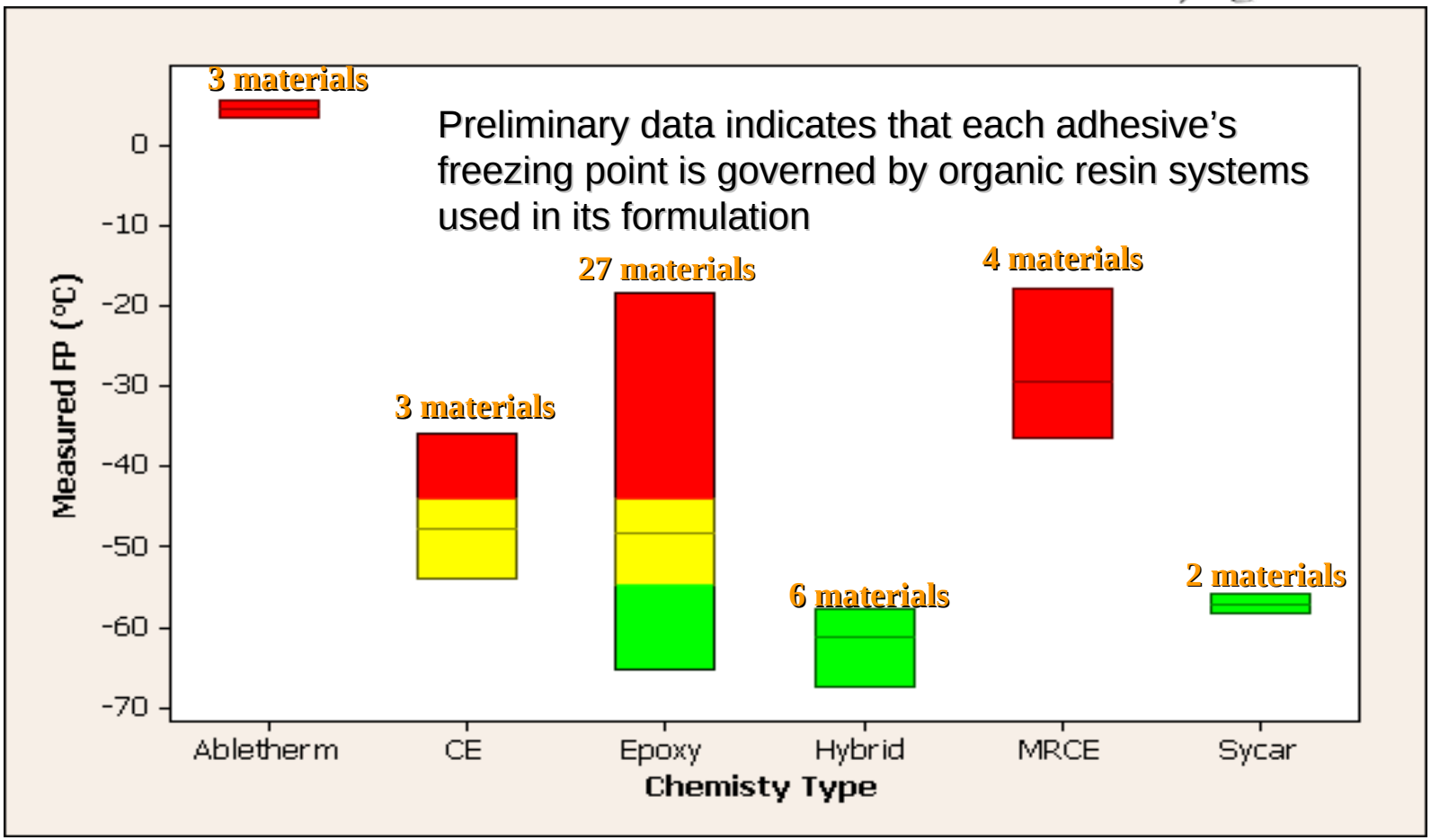
Freezing Point Characterization



Risk of FTVs
Low Risk
Medium Risk
High Risk

45 materials tested:
-Different Chemistries
-Different Fillers

Freezing Point By Chemistry



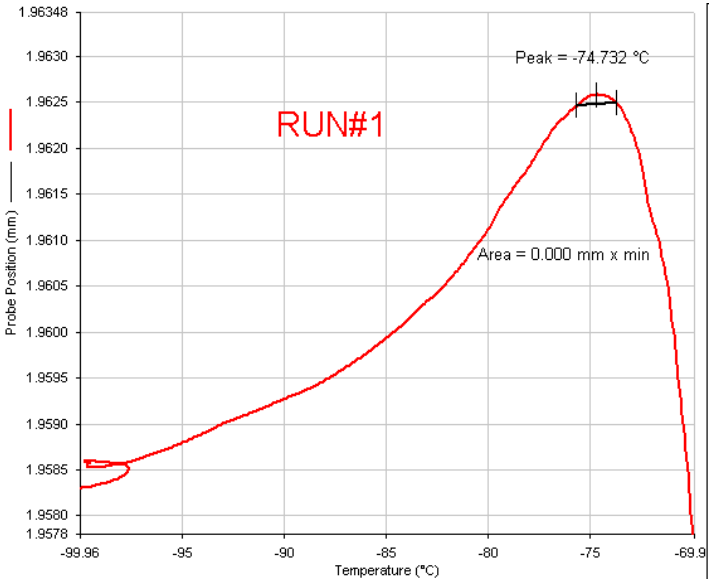
Risk of FTVs

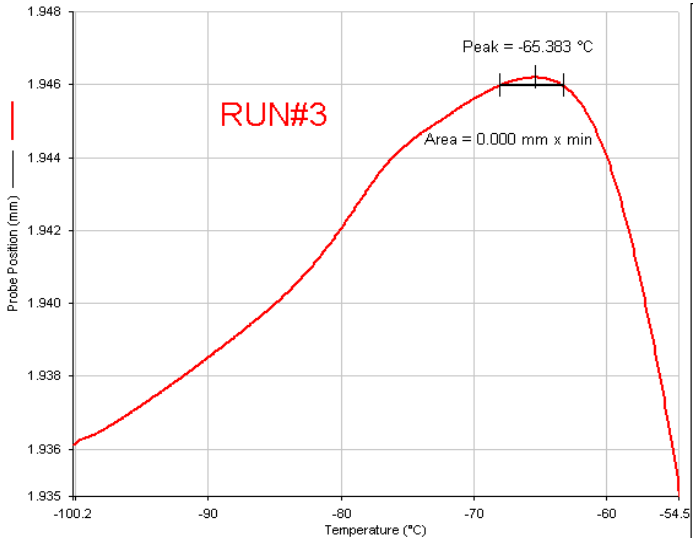
Low Risk **Medium Risk** **High Risk**

Note: Based on testing:

- Abletherm, MRCE, CE and some epoxy systems pose the highest risk of FTVs
- BMI & Sycar systems pose the lowest risk of FTVs

Freezing Point Data





Freezing Point Comparison

- The freezing point for QMI529HT was compared versus other standard conductive die attach adhesives: -

Freezing Point Comparison For QMI529HT versus Selected Leadframe Die Attach Conductive Adhesives					
Material	Chemistry Type	Batch #	Run No.	Freezing Point (°C)	Mean Freezing Point (°C)
FS849-TI	Hybrid	5227987	1	-71.28	-71.945
			2	-72.61	
84-1LMISR8	Epoxy	5285530	1	46.80	-46.48
			2	46.16	
8600	Hybrid	5163850	1	-68.40	-70.30
			2	-72.20	
QMI529HT	BMI	#	1	-74.51	-68.54
			2	-74.73	
			3	-65.38	

- QMI529HT has low risk potential for the formation of FTV in Henkel's standard shipping method (dry ice) and storage recommendation (–40℃ freezer).

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Other Factors Effecting on FTV

Source: *FTV Presentation by Derek Wyatt*

(Tech Serv Dept-Version 1.5)

Other Factors Effecting FTV Occurrences

- **Freezing point of the adhesive**
  - **Adhesive freezing points range from +5°C to -70°C**
    - Lower freezing point adhesives generally perform worse than higher freezing point adhesives
    - Lower storage temperatures will increase the risk of FTVs.

- **Storage temperature**
  - **Delta between ambient and actual syringe temperature when pulled for thaw**
    - Larger deltas between storage temperature and freezing point of the adhesive will increase the likelihood of FTVs.

- **Freezer Variability**
  - **A freezer is just like an oven. Its temperature will vary based on loading and usage.**
  - **Some freezers have been observed to have a 30°C variation from top to bottom which would results in sporadic FTV performance.**

- **Piston gap**
  - **A piston gap can work is some cases but its effectiveness will be governed by**
    - Actual storage temperature of the adhesive (not set temperature)
    - Ambient temperatures (delta T)
    - Adhesive type
    - Syringe handling while frozen

Other Factors Effecting FTV Occurrences

- Piston design
  - Loose fitting pistons (no flanges) can decrease FTV performance.
- Syringe ID/length
  - Longer dimensions will increase stress as differential shrinkage takes place between the adhesive and syringe
- CTE differences between syringe and piston.
- Shrinkage rate of uncured adhesive
  - May differ between chemistries.
- Adhesion of adhesive to syringe wall.
- Adhesive volume relative to syringe length.
- Syringe handling by the customer

Handling Recommendations

Source: ***FTV Presentation by Derek Wyatt***

(Tech Serv Dept-Version 1.5)

Handling Recommendations

- **Precautions**
  - **All frozen shipments are shipped using dry ice**
  - **The dry ice temperature used to ship frozen adhesives is approximately –80°C.**
  - **Handling of this material requires protective gloves designed to withstand these extremely cold temperatures**
  - **Protective gloves should be used during the handling of the syringe box and frozen syringes**

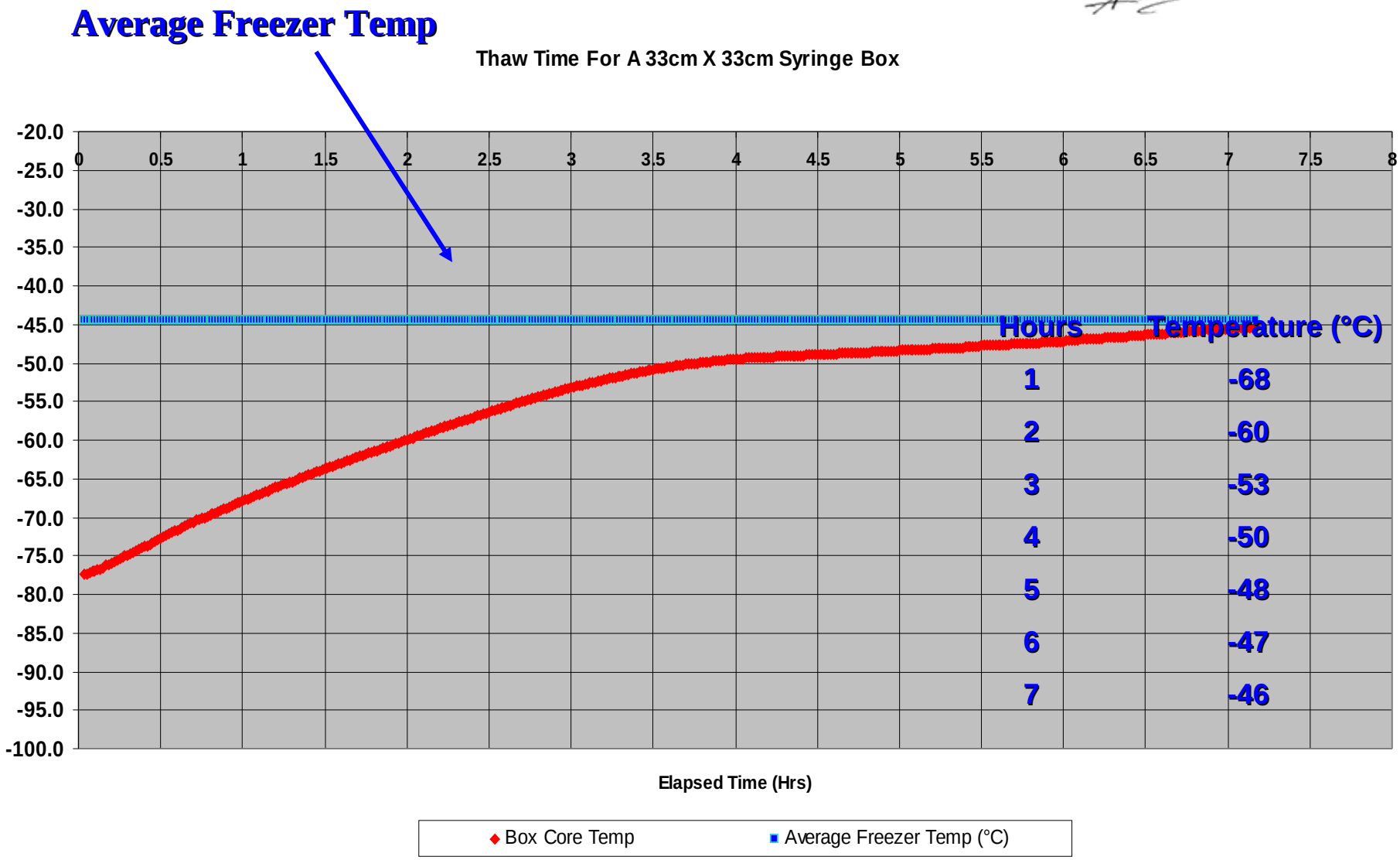
Handling Recommendations

- **Incoming inspection**
  - **It is not recommended that individual syringes go through an incoming inspection**
  - **The practice of removing the syringes from the syringe box and handling to visually inspect them has been linked to an increase in freeze thaw voiding frequency**
  - **If incoming inspection or quantity verification is deemed necessary, it is recommended that the syringe box be immediately placed into a –40°C freezer and allowed to equilibrate for at least 6 hours.**
  - **Inspections can then be done in a manner that keeps the syringes as close to the recommended storage temperature (-40°C) as possible**
  - **Avoid prolonged handling of the syringes since it will increase the risk of FTVs.**

Handling Recommendations (Continued)

- **Unpacking**
  - **Open shipping box as close to the storage freezer as possible. Only open one shipping box at a time and transfer contents to the storage freezer before moving on to the next shipping box**
  - **While wearing thermal gloves, transfer the white syringe boxes a quickly a possible to the storage freezer and allow the contents to warm to the storage temperature for at least 6 hours**
    - Temperatures in an unopened syringe box can rise enough to cause freeze thaw voiding in as little as 5 minutes if left out in ambient temperatures

Thaw Time For A 33cm X 33cm Syringe Box



Handling Recommendations (Continued)

- **Syringe thaw technique**
  - **When ready to use the adhesive, transfer the needed syringes from the syringe box to a designated thaw area using thermal gloves. While frozen, only handle the syringe by the flanges located at the top end of the syringe. This will minimize thermal shock and reduce the likelihood of FTVs from forming**
  - **Caution, syringes are extremely brittle at temperatures around –40°C and below. Dropping the syringe could fracture the syringe wall or syringe tip**
- **During thaw, the syringes should be stored in the vertical position (if possible, use a test tube holder). Thaw times vary depending on syringe size.**
  - **10 cc syringe thaw time: ~30 minutes**
  - **30 cc syringe thaw time: ~60 minutes**
- **Before use, wipe off any residual condensation**

Henkel

A Brand like a friend

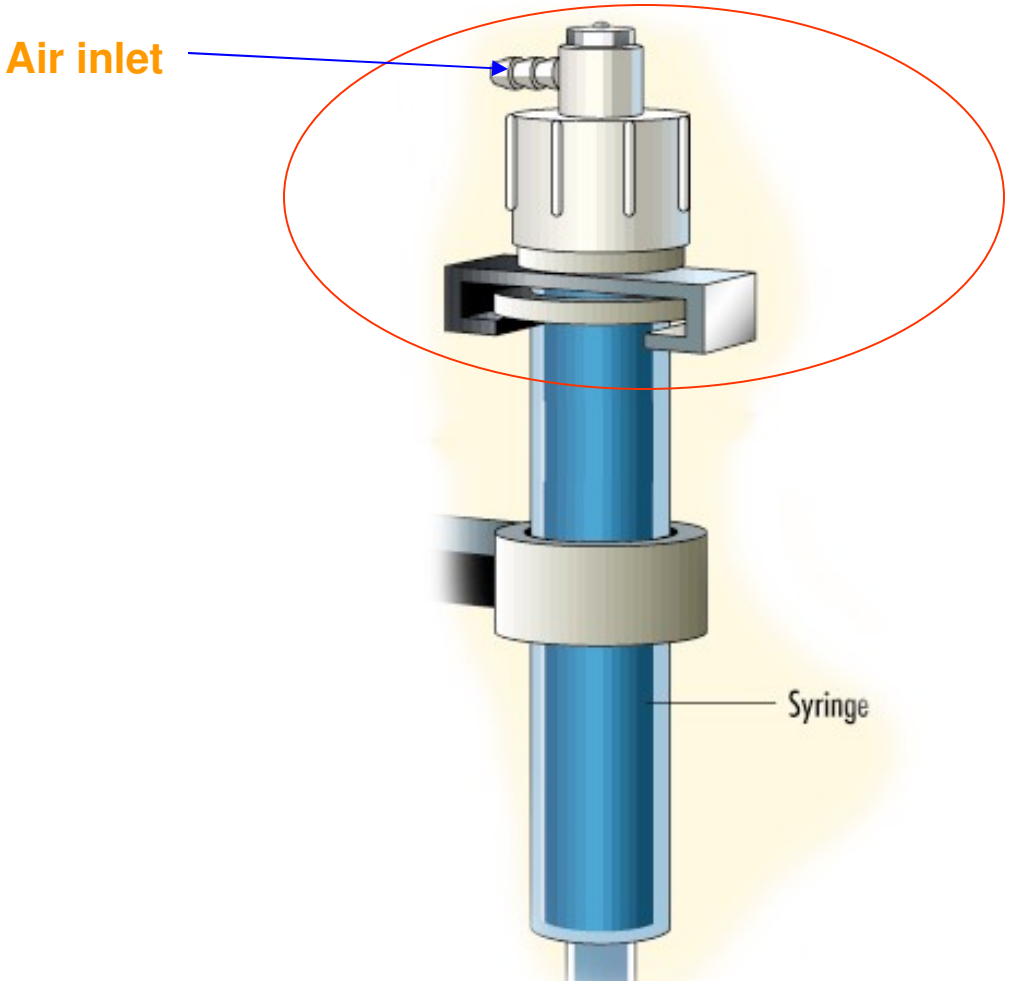
Needle Size Evaluation

EFD Needle Color Vs. Size

		ID size		OD size	
Color	Gage	(in)	(mm)	(in)	(mm)
Olive	14	0.061	1.54	0.072	1.83
Amber	15	0.054	1.36	0.065	1.65
Grey	16	0.047	1.19	tapered	tapered
Green	18	0.033	0.84	0.05	1.27
Pink	20	0.024	0.60	0.036	0.91
Purple	21	0.02	0.51	0.032	0.82
Blue	22	0.016	0.41	0.028	0.72
Orange	23	0.013	0.34	0.025	0.64
Red	25	0.01	0.26	0.02	0.51
Clear	27	0.008	0.21	0.016	0.41
Lavender	30	0.006	0.16	0.012	0.31
Yellow	32	0.004	0.11	0.009	0.23

- **The dispense test is focusing on G22 (Ablestik recommended size)**
- **G25 is most common used for the small die size application (<2mm).**

Pneumatic Dispense



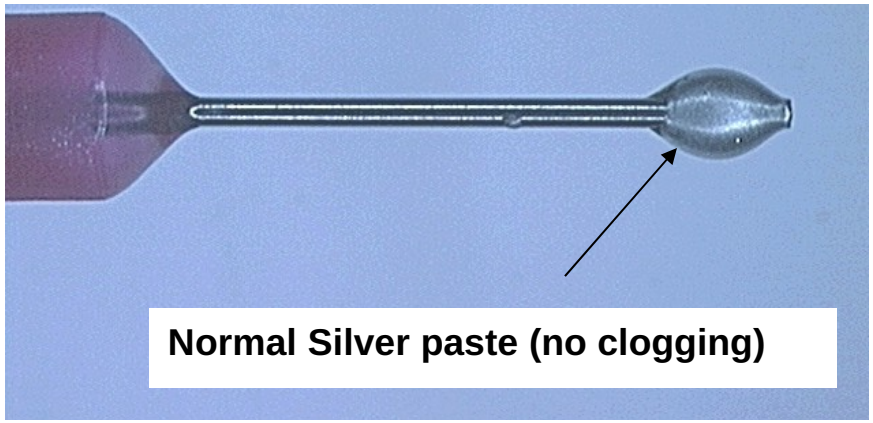
Air pressure forces the adhesive through the dispense needle.

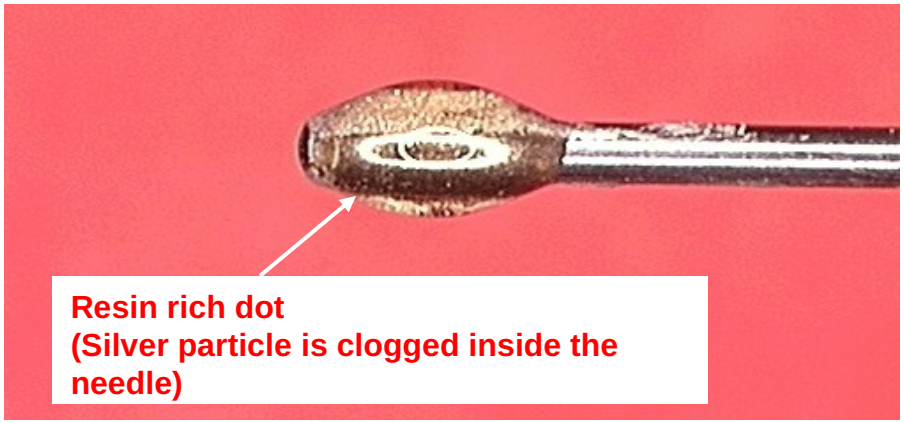
Limitation : Speed affects consistency due to limited pressure supply

: Viscosity dependent.

Reference Needle Clogging Image

G25 Needle size





Potential cause (Needle clogging) :

2) Needle size is not suitable (the ID is too small) for DA paste

3) Use material over recommended work life

4) Needle contamination

Result

- The following results were obtained for needle blocking trials with QMI529HT and selected other adhesives: -

Needle Clogging Experiment for Selected Conductive Adhesives					
Product	27 Guage	25 Guage	23 Guage	22 Guage	BATCH
529HT	No clog	No clog	No clog	No clog	LP 83662605
8290	No clog	No clog	No clog	No clog	5298032
FS849-TI	No clog	No clog	No clog	No clog	12/6/2008
QMI 519	No clog	No clog	No clog	No clog	#

- All test materials dispense without problems, even at very narrow needle diameters.

NB. QMI529HT took twice as long to dispense than 8290 and FS849-TI due the difference in products viscosity.