Die Attach Paste ABP8142B Application Data Package (Version 1)

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Contents

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Product description & key material properties

Product description & key material properties

-- Product Description

- Henkel Die attach paste ABP8142B is developing a silicone material technology for MEMS application which can offer low modulus / stress, no bleed and higher adhesion.

- ABP8142B is recommended for BT substrate;
- Trail run Cu and PPF L/F performance

Product description & key material properties

-- key Material Properties

Item		ABP8142B	Competitor
Base Resin		Silicone	Silicone
Filler type		Silicon	Silicon
Density / Specific Gravity (g/cc)		1.17	1.25
Viscosity @ 25 ℃(cps) (@5rpm)		15500	34000
Thixotropic Index		3.6	3.4
Working Life @ 25 ℃(hours)		48	48
DSC onset point (℃)		122.8	125.5
DSC peak (℃)		128.2	128.5
DSC Delta H (J/g)		26.0	26.2
Tg (oC)		-55.5	-57.3
CTE Above Tg (ppm/ oC)		345	295
Dynamic Tensile Modulus (Mpa)	'@ -65 oC	16.22	33.83
	@ 25 oC	2.25	10.09
	@ 150 ^{o}C	2.25	9.56
	@ 200 ^{o}C	2.49	9.72
	@ 250 ^{o}C	2.66	11.4
Weight loss on cure (% by weight)		1.42	0.12
Dielectric constant		3.00	2.90

Item			ABP8142B	Competitor
Adhesion Die: 2X2mm	BT	RT DSS (Kg)	3.60	3.00
		HDSS @260C (Kg)	2.22	2.77
		HWDSS @260C (Kg)	2.04	1.06
	Cu L/F	RT DSS (Kg)	4.19	2.78
		HDSS @260C (Kg)	2.67	2.52
		HWDSS @260C (Kg)	3.03	3.60
	PPF L/F	RT DSS (Kg)	4.60	4.58
		HDSS @260C (Kg)	2.14	3.80
		HWDSS @260C (Kg)	3.15	2.96
RBO (%) Cure condition 150C@30min	After	BT	No	No
		Cu L/F	5.37	6.33
		PPF L/F	5.68	4.39
Dispensing	Noddle ID size range		>0.26mm	>0.34mm
	Fail rate (on noddle size: 0.41mm)		8.89%	20.30%
Warpage (um) Henkel BT substrate (5x5mm with 6mil die)			1.649	1.374
Open time (hours) (at least)			2	NA
Stage time (hours) (at least)			6	NA
Hardness Shore A			42	72

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Cure profile study

Cure profile study
-- DOE design

StdOrder	RunOrder	CenterPt	Blocks	Temperature	Time	HDSS@260C
5	1	0	1	150	60	
1	2	1	1	125	30	
4	3	1	1	175	90	
3	4	1	1	125	90	
2	5	1	1	175	30	

Full Factorial Design

Factors: 2 Base Design: 2, 4
Runs: 50 Replicates: 10
Blocks: 1 Center pts (total): 10

- L/F: Henkel in-house BT substrate
- Die: 2x2 mm with 15mil thickness
- Sample size: 10 unites/leg

Cure profile study
-- DOE design

Factorial Fit: 260C@HDSS versus Temperature, Time

Estimated Effects and Coefficients for 260C@HDSS (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		1799.49	63.94	28.14	0.000
Temperature	234.64	117.32	63.94	1.83	0.073
Time	102.78	51.39	63.94	0.80	0.426
Temperature*Time	-63.47	-31.73	63.94	-0.50	0.622
Ct Pt		-38.56	142.98	-0.27	0.789

S = 404.407 PRESS = 8891079
R-Sq = 8.78% R-Sq(pred) = 0.00% R-Sq(adj) = 0.67%

Analysis of Variance for 260C@HDSS (coded units)

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	2	656183	656183	328092	2.01	0.146
2-Way Interactions	1	40278	40278	40278	0.25	0.622
Curvature	1	11897	11897	11897	0.07	0.789
Residual Error	45	7359536	7359536	163545		
Pure Error	45	7359536	7359536	163545		
Total	49	8067894				

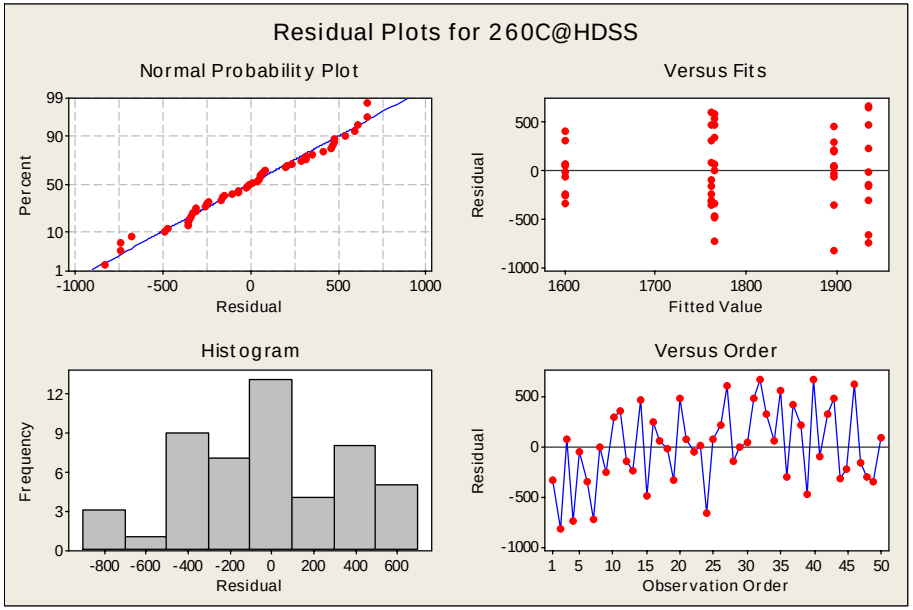
Unusual Observations for 260C@HDSS

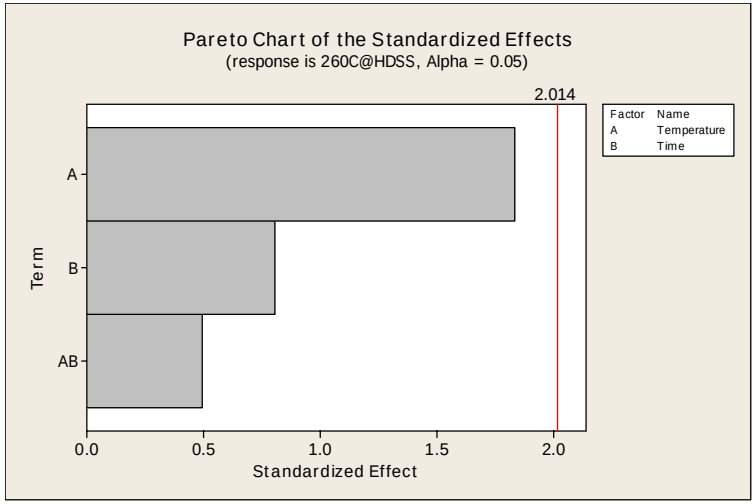
Obs	StdOrder	260C@HDSS	Fit	SE Fit	Residual	St Resid
2	2	1065.60	1897.15	127.88	-831.55	-2.17R

R denotes an observation with a large standardized residual.

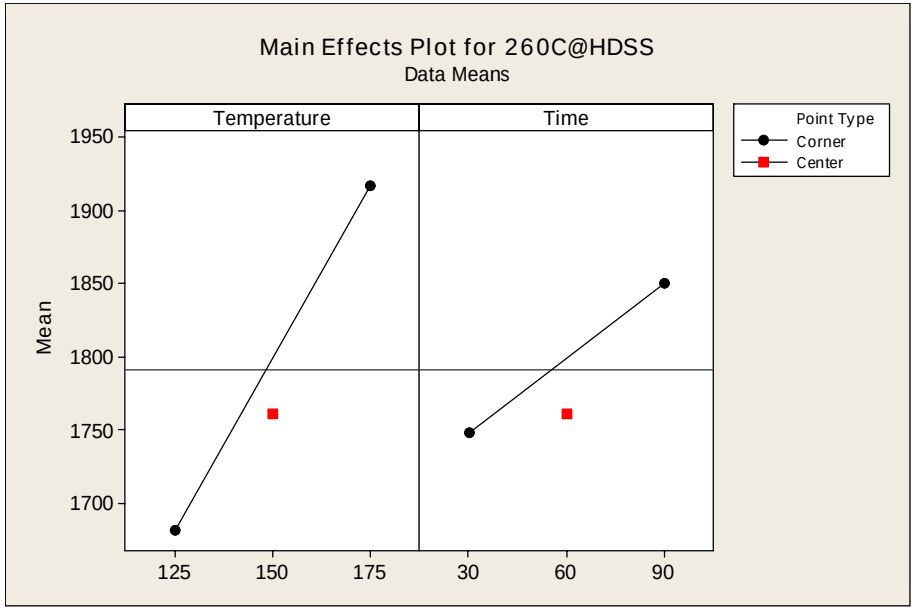
Estimated Coefficients for 260C@HDSS using data in uncoded units

Term	Coef
Constant	612.013
Temperature	7.23130
Time	8.0596
Temperature*Time	-0.0423100
Ct Pt	-38.562





Cure profile study
-- DOE design



- HDSS have no such significant main effect .
- Residual plot show the residual matching the criteria of random distribution, symmetry zero, fitting balance and no special trend.
- HDSS have no significant difference by temperature and time increasing (temperature:125C~175C, time: 30~90mins) ;

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Cure profile study

-- DOE design

One-way ANOVA: 125C@30min, 125C@90min, 150C@60min, 175C@30min, 175C@90min

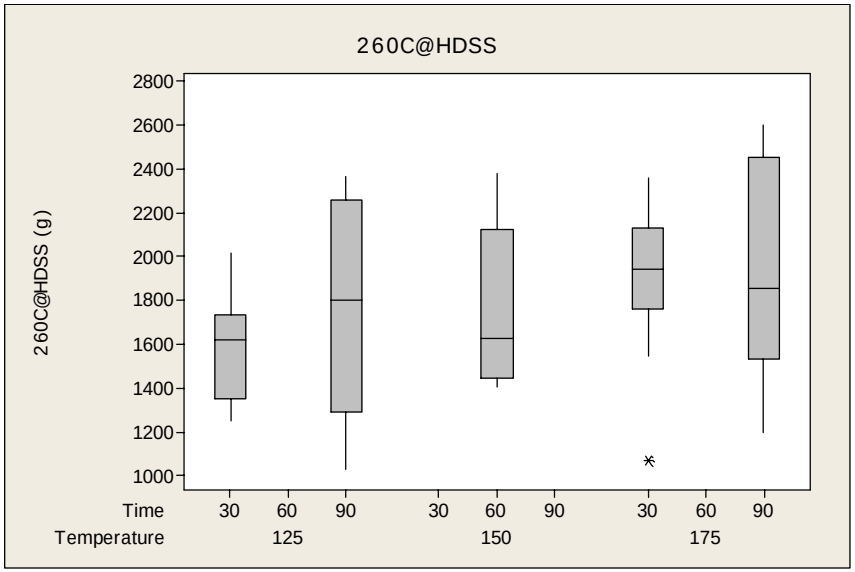
Source	DF	SS	MS	F	P
Factor	4	708358	177089	1.08	0.376
Error	45	7359536	163545		
Total	49	8067894			

S = 404.4 R-Sq = 8.78% R-Sq(adj) = 0.67%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	------+---------+---------+---------+---
125C@30min	10	1599.1	244.5	(---------*---------)
125C@90min	10	1765.3	487.4	(----------*---------)
150C@60min	10	1760.9	357.8	(---------*----------)
175C@30min	10	1897.2	366.6	(---------*---------)
175C@90min	10	1936.5	507.9	(---------*----------)
				------+---------+---------+---------+---
				1500 1750 2000 2250

Pooled StDev = 404.4



Cure profile have no significant difference

- Normal customer profile: 150C@30min
- 150C@30min as cure profile evaluated

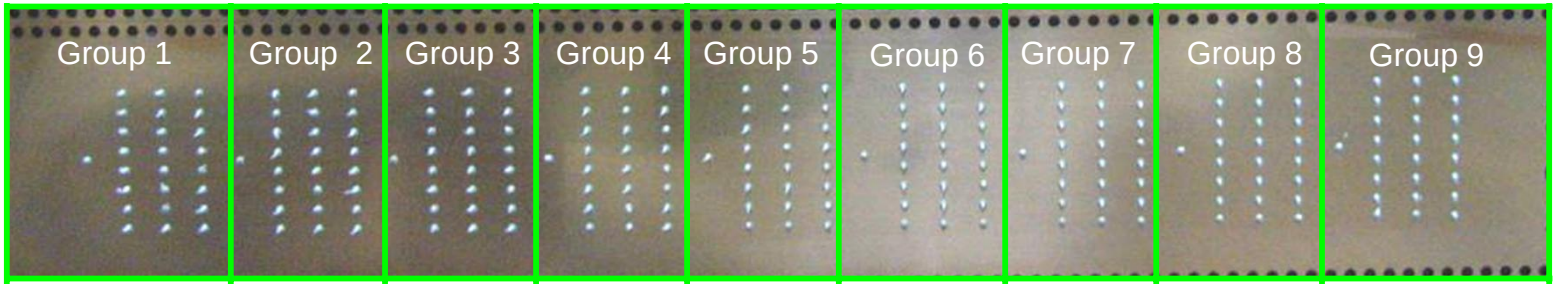
Cure profile study
-- Summary

- Based on DOE data analysis, ABP8142B: 30mins ramp to 150C, then hold 30min on 150C as cure profile to evaluate;

Dispensing

Dispensing
-- Dot Dispensing Test Methodology

- Totally dispensing 9 groups, 25 dots each group. Each group has the same parameters except different nozzle retract distance, from high to low. Earlier failure, worse dispensing performance



11.4mm	10.2	8.89	7.62	6.35	5.08	3.81	2.54	1.27mm

Good Sample

Fail Sample

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Dispensing
-- Plan

- Test Sample: ABP8142B & competitor
- Machine: CAMLOT FX-D
- Nozzle size checked: dispensing performance
- Sample size: 3 strips each batch, total 675 dots each

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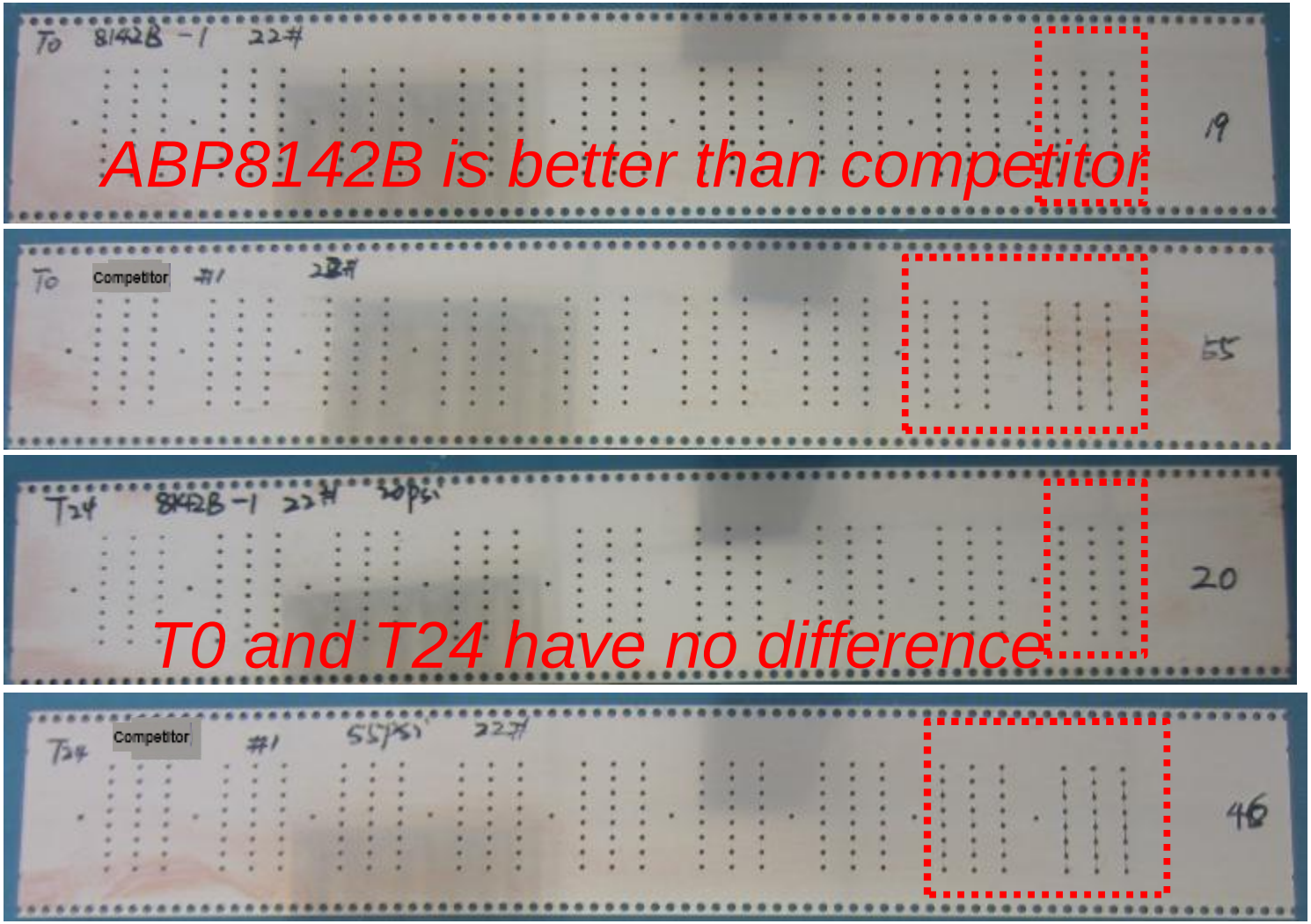
Dispensing
-- Nozzle size checked

Paste type	Needle ID size			
	0.21mm (#27)	0.26mm (#25)	0.34mm (#23)	0.41mm (#22)
ABP8142B	Fail	Pass	Pass	Pass
Competitor	Fail	Fail	Pass	Pass

- ABP8142B nozzle size: > ID: 0.26mm(#25)
- Competitor nozzle size: ID > 0.34mm(#23)

Dispensing

-- Dot dispensing results (ID: #22)



Dispensing

-- Dot dispensing results

One-way ANOVA: ABP8142B T0, Competitor T0, ABP8142B T24, Competitor T24

```
Source  DF        SS        MS      F      P
Factor   3  0.040591  0.013530  43.03  0.000
Error    8  0.002515  0.000314
Total   11  0.043106
S = 0.01773   R-Sq = 94.17%   R-Sq(adj) = 91.98%
                                Individual 95% CIs For Mean Based on
                                Pooled StDev
Level            N     Mean    StDev  --------+---------+---------+---------+-
ABP8142B T0      3  0.08889  0.01176   (----*---)
Competitor T0    3  0.20296  0.03276                      (----*---)
ABP8142B T24     3  0.08593  0.00513  (----*----)
Competitor  T24  3  0.20444  0.00444                      (----*----)
                                --------+---------+---------+---------+-
                                      0.100     0.150     0.200     0.250

Pooled StDev = 0.01773
```

Paste	Total Dispensing Dot	Defective Dot	Fail Rate
ABP8142B T0	675	60	8.89%
ABP8142B T24	675	58	8.59%
Competitor T0	675	137	20.30%
Competitor T24	675	138	20.44%

- ABP8142B is better than Competitor
- T0 and T24 have no significant difference

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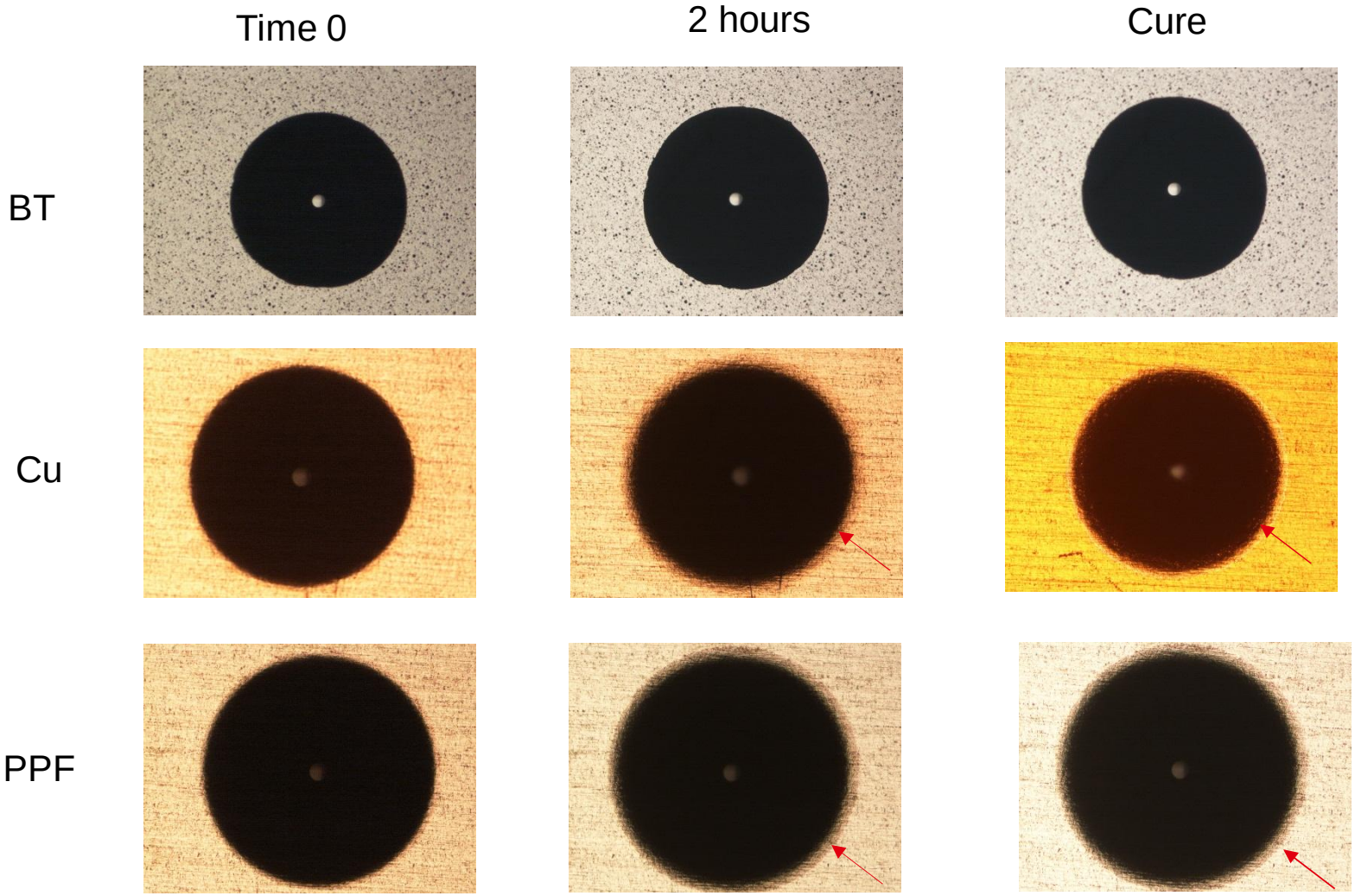
Dispensing
-- Summary

- Noddle size application:
  - ABP8142B noddle size: > ID: 0.26mm(#25)
  - Competitor noddle size: ID > 0.34mm(#23)
- Dispensing performance: ABP8142B is better than Competitor; and T0 and T24 have no significant difference;

Resin Bleed out (RBO) Evaluation

Resin Bleed out (RBO) Evaluation -ABP8142B



- No RBO on BT, slight RBO on Cu and PPF after 2hr and cure, RBO rate: 1.6~9%

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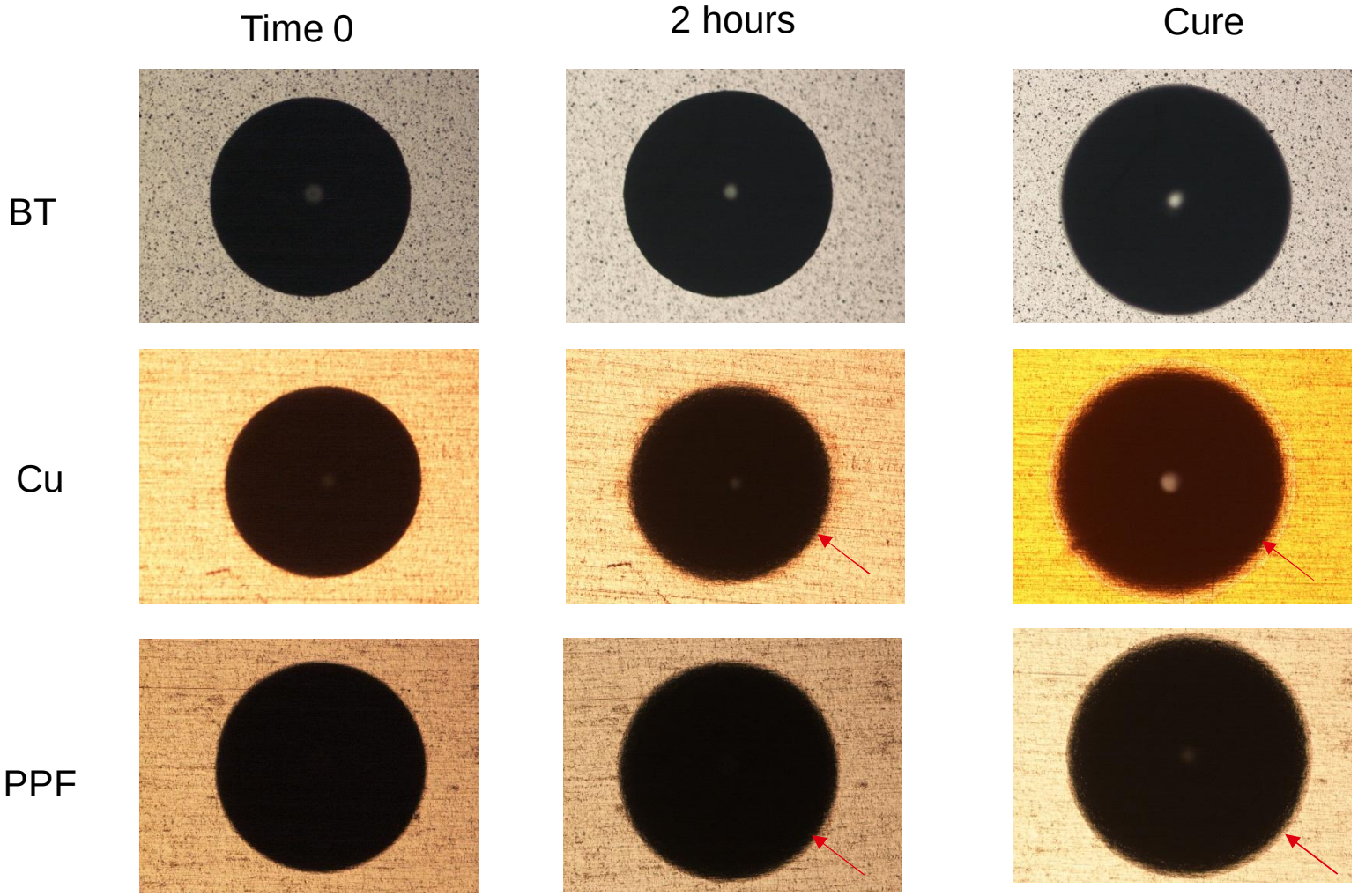
Resin Bleed out (RBO) Evaluation - Competitor



- No RBO on BT, slight RBO on Cu and PPF after 2hr and cure, RBO rate: 2.1~8.4%

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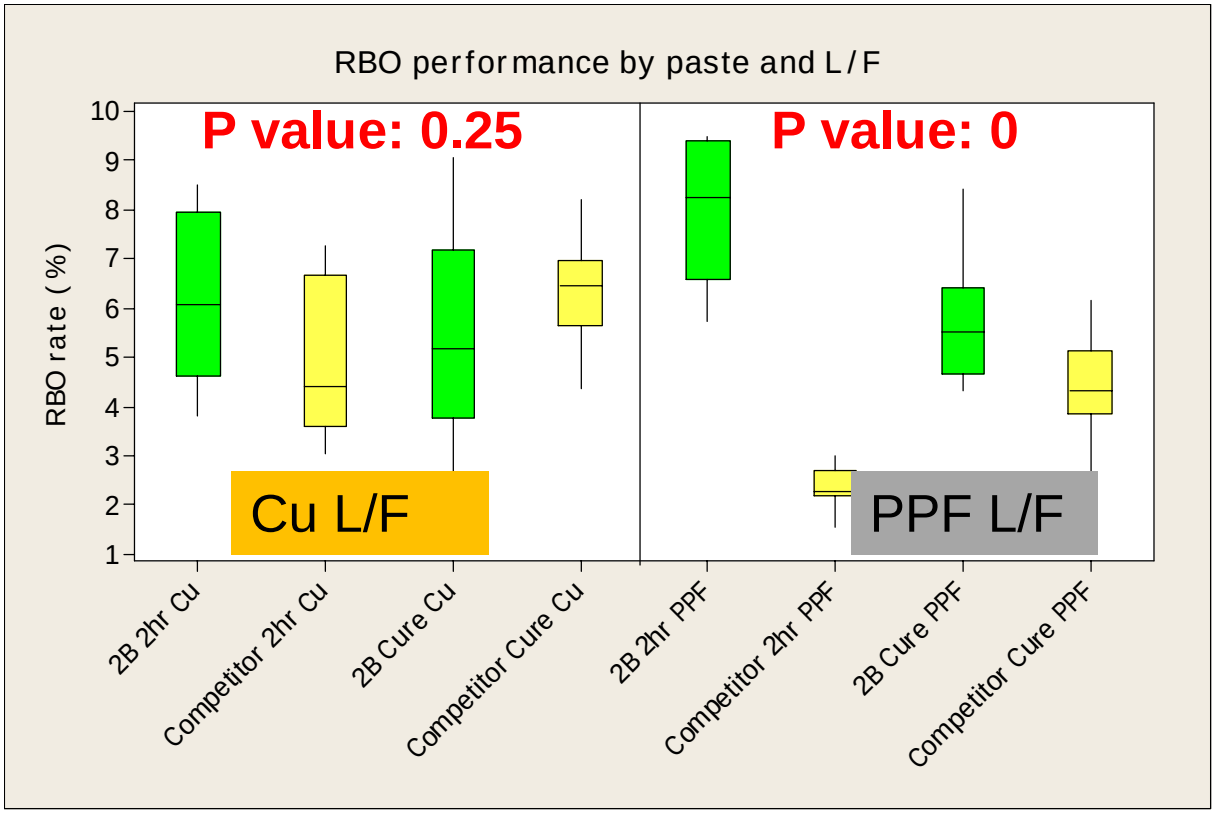
Resin Bleed out (RBO) Evaluation - compared



- On Cu L/F: ABP8142B and Competitor have no significant difference
- On PPF L/F: RBO rate: Competitor is better than 8142B

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Resin Bleed out (RBO) Evaluation
-- Summary

- ABP8142B has excellent RBO performance on BT substrate
- ABP8142B has slight RBO on Cu and PPF after 2hr and cure, RBO rate: 1.6~9%
- Compared with Competitor:
  - ABP8142B have no significant difference on BT and Cu L/F
  - On PPF L/F: ABP8142B RBO a little higher than Competitor

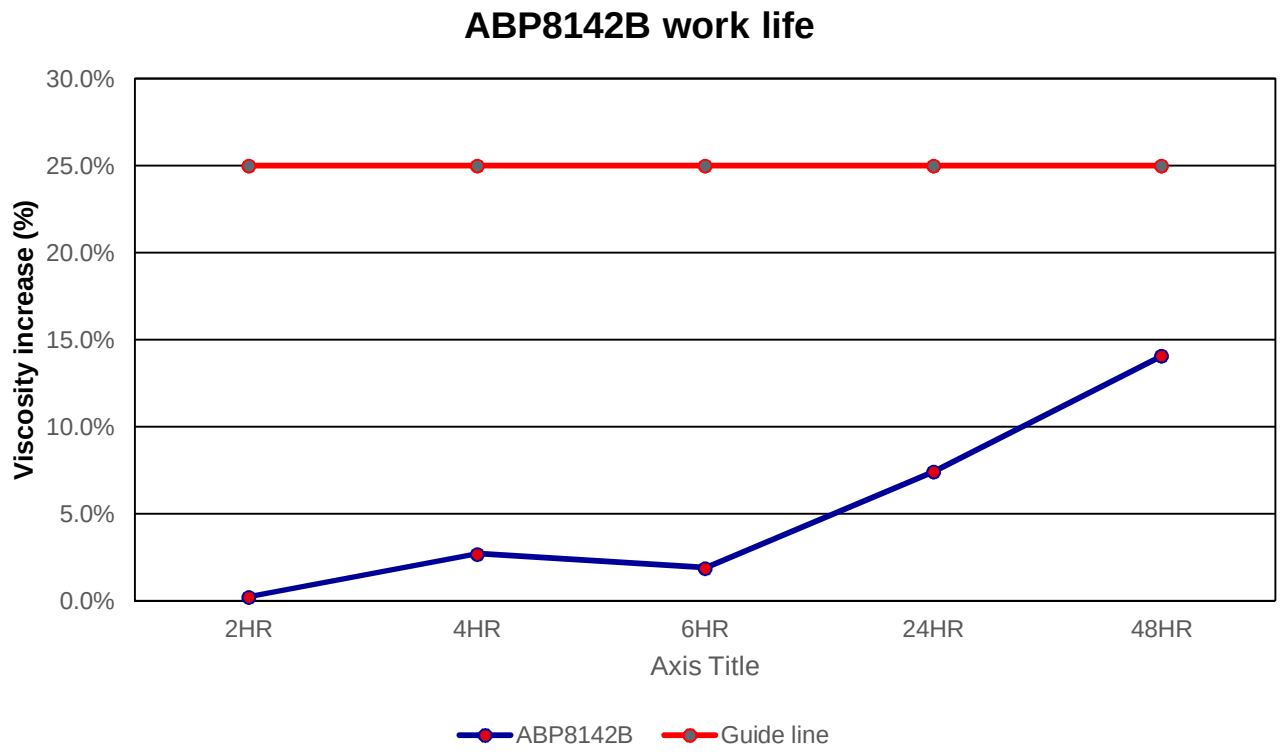
Work Life Evaluation

Work Life Evaluation
-- Work Life Definition

- Henkel define the product's work life by chemical work life
  - ✓ Chemical work life is determined by under room temperature, the viscosity increase is less than 25%

Work Life Evaluation

-- Viscosity increasing @ Different Temperature



- The viscosity increase are all smaller than 25% work life at least 48hours

Work Life Evaluation
-- Summary

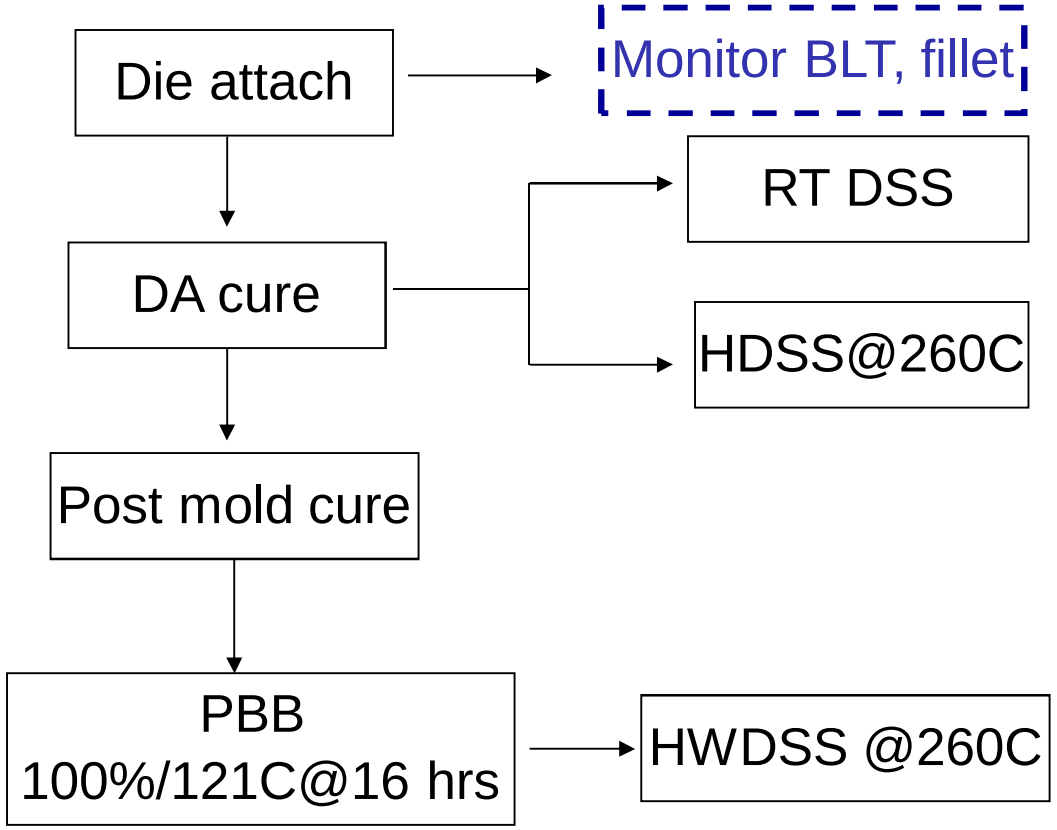
- ABP 8142B has 48 hours work life at room temperature and the viscosity increase is smaller than 25% within 48 hours

Adhesion performance

Adhesion performance
-- DOE plan and flow

- Adhesion compared: RT, HDSS and HWDSS by difference L/F
- Paste: ABP8142B and Competitor
- L/F: Henkel in-house BT Cu/PPF L/F
- Die thickness:15mil
- Curing profile: 30min ramp up to the setted temperature, hold 30min
- PMC: 175 ℃, 4 hours
- Sample size: 10 unites/leg

- Test flow



HDSS: hot die shear strength

HWDSS: hot wet die shear strength, after parr bomb.

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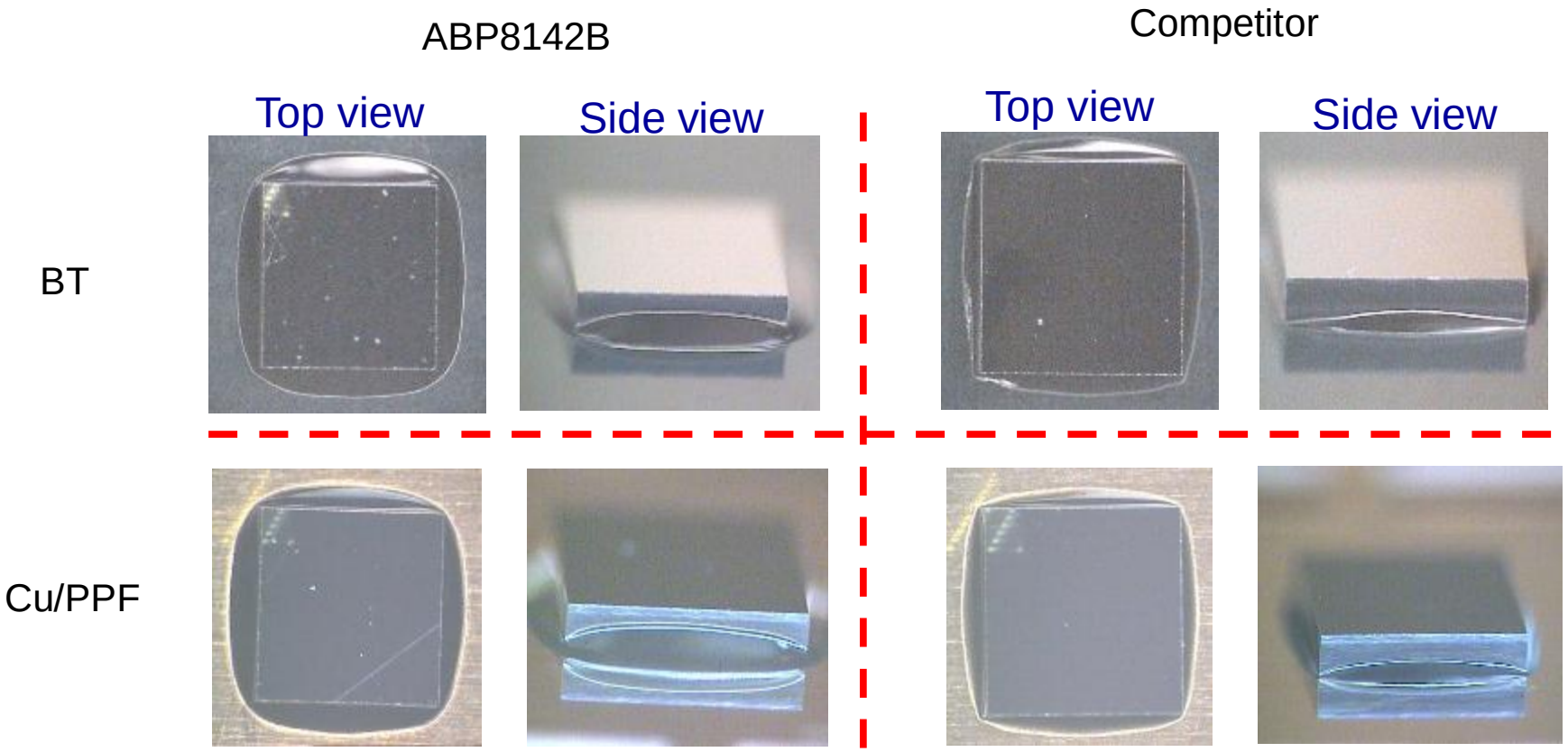
Adhesion performance
-- BLT, fillet checked



- BLT control: ~25um

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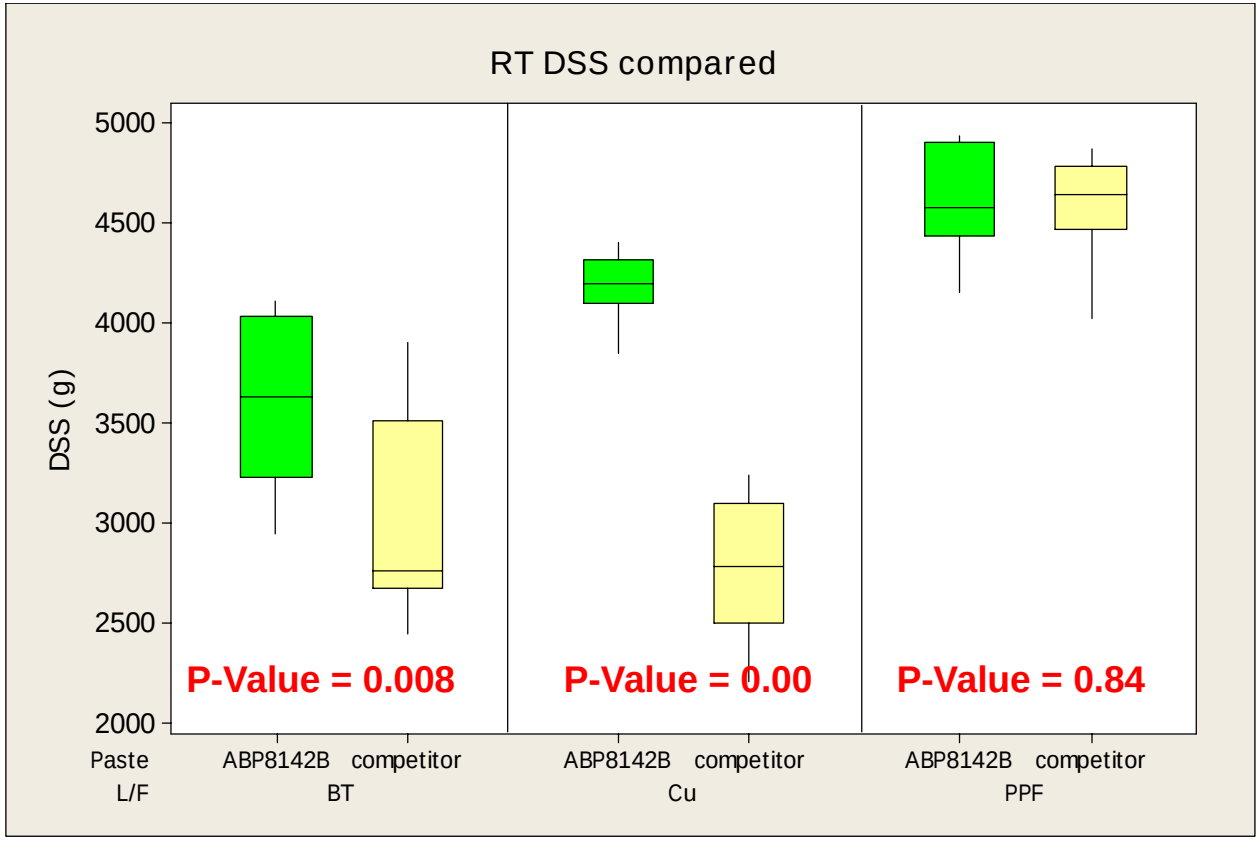
Adhesion performance
-- RT DSS results analysis



- BT: ABP8142B>Competitor;
- Cu L/F: ABP8142B>Competitor;
- PPF L/F: ABP8142B ≈ Competitor;

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Adhesion performance
-- RT DSS result analysis

General Linear Model: RT versus L/F, Paste

Factor	Type	Levels	Values
L/F	fixed	3	BT, Cu, PPF
Paste	fixed	2	ABP8142B, competitor

Analysis of Variance for RT, using Adjusted SS for Tests

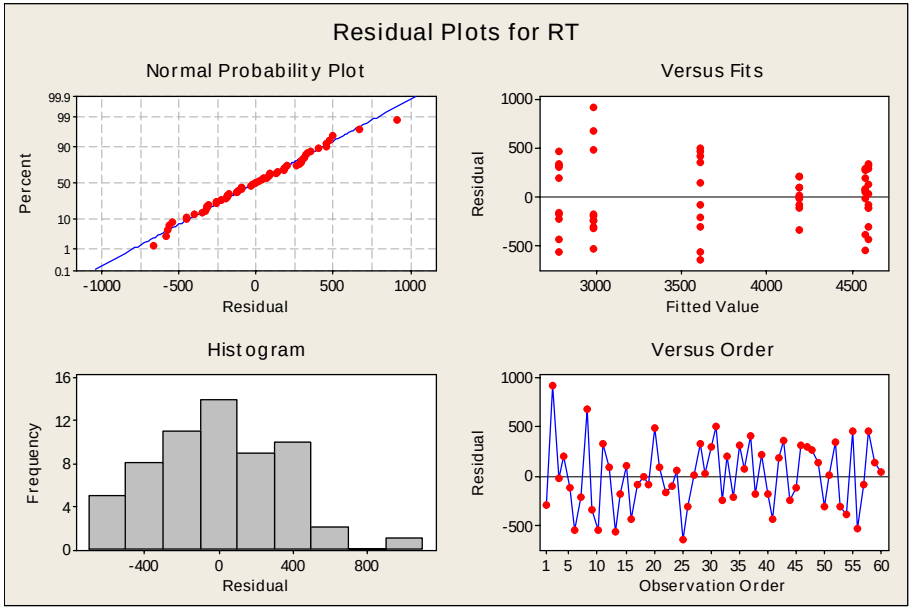
Source	DF	Seq SS	Adj SS	Adj MS	F	P
L/F	2	19515644	19515644	9757822	79.06	0.000
Paste	1	7073628	7073628	7073628	57.31	0.000
L/F*Paste	2	4870468	4870468	2435234	19.73	0.000
Error	54	6664852	6664852	123423		
Total	59	38124591				

S = 351.316 R-Sq = 82.52% R-Sq(adj) = 80.90%

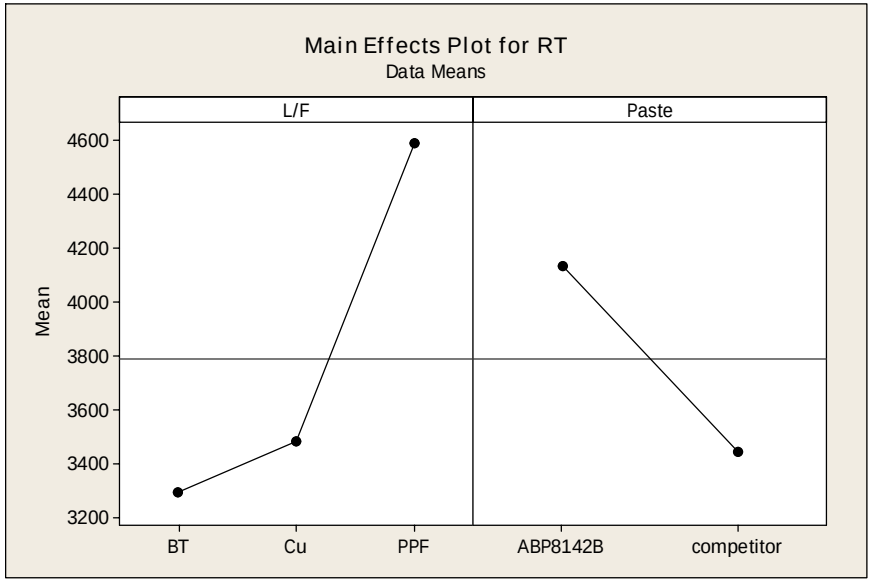
Unusual Observations for RT

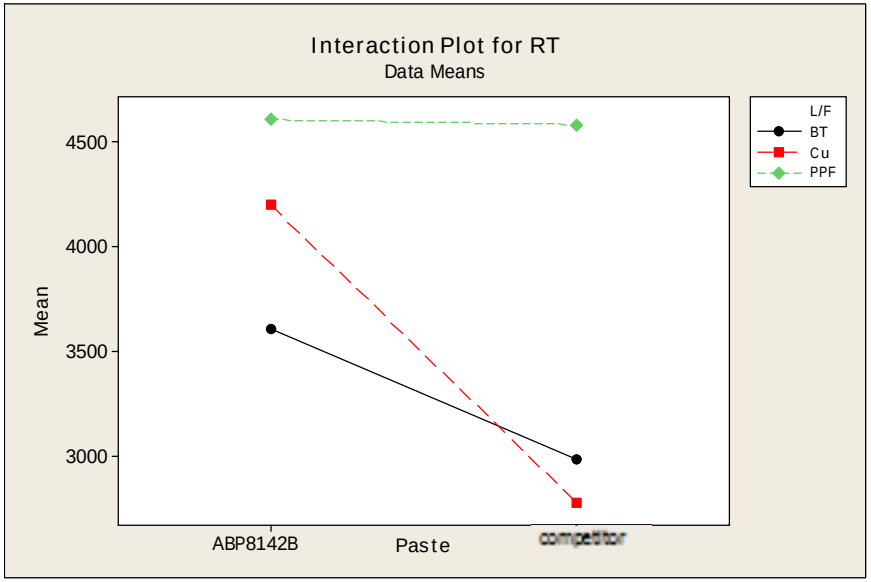
Obs	RT	Fit	SE Fit	Residual	St Resid
2	3901.60	2985.82	111.10	915.78	2.75 R
8	3656.20	2985.82	111.10	670.38	2.01 R

R denotes an observation with a large standardized residual.



Adhesion performance
-- RT DSS result analysis





- RT SS have such significant main effect with L/F and paste type, and the interaction are also very significant.
- Residual plot show the residual matching the criteria of random distribution, symmetry zero, fitting balance and no special trend.
- 1) RT DSS compared by paste: ABP8142B > Competitor;
  2) RT DSS compared by L/F: PPF>Cu>BT

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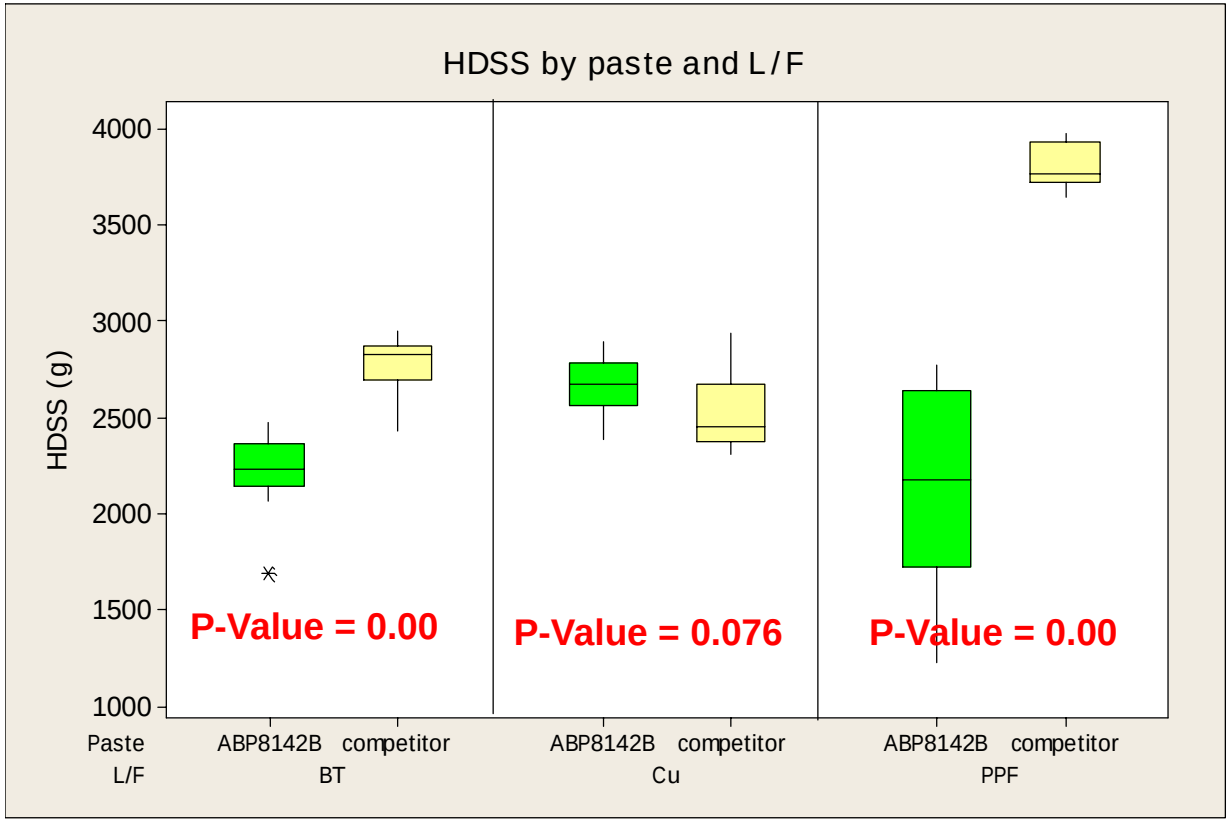
Adhesion compared
-- HDSS results analysis



- BT: Competitor >ABP8142B;
- Cu L/F: ABP8142B≈ Competitor;
- PPF L/F: Competitor >ABP8142B;

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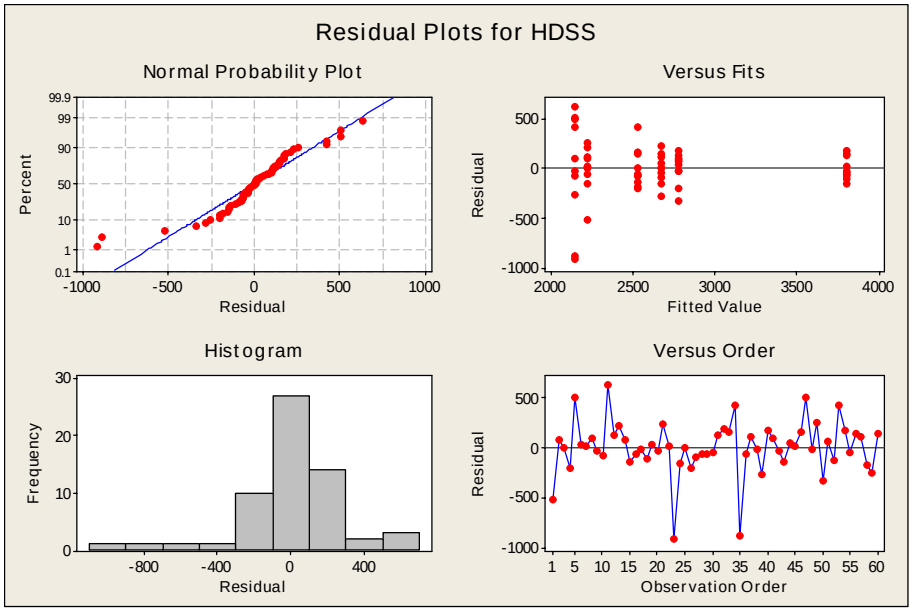
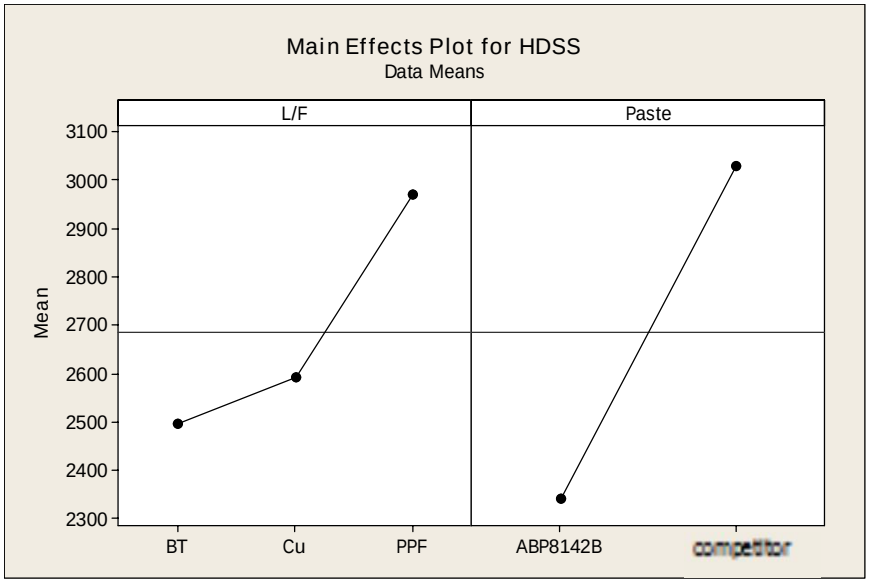
Adhesion performance
-- HDSS result analysis

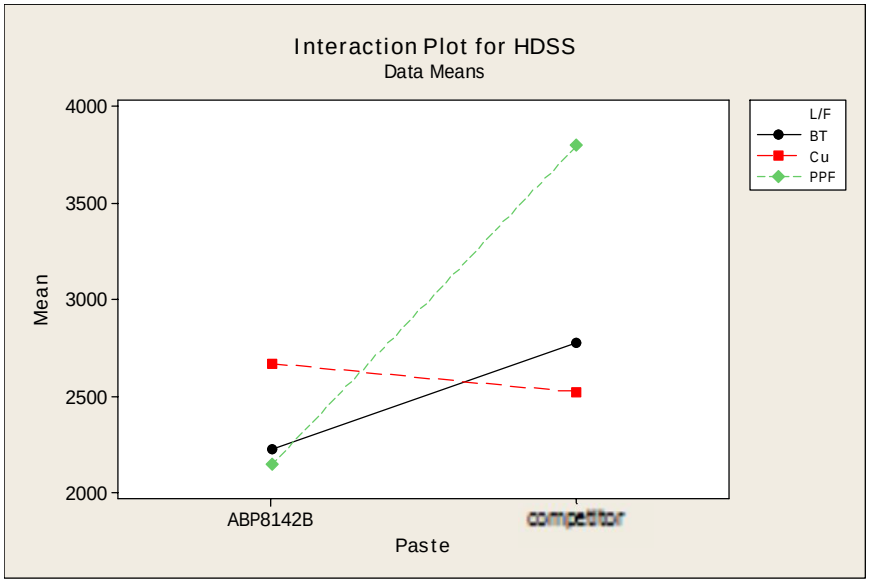
General Linear Model: HDSS versus L/F, Paste

```
Factor  Type   Levels  Values
L/F     fixed       3  BT, Cu, PPF
Paste   fixed       2  ABP8142B, competor

Analysis of Variance for HDSS, using Adjusted SS for Tests
Source      DF    Seq SS   Adj SS   Adj MS      F      P
L/F          2   2504040  2504040  1252020  16.45  0.000
Paste        1   7076375  7076375  7076375  93.00  0.000
L/F*Paste    2   8258482  8258482  4129241  54.27  0.000
Error       54   4108888  4108888    76091
Total       59  21947785

S = 275.845   R-Sq = 81.28%   R-Sq(adj) = 79.55%

Unusual Observations for HDSS

Obs     HDSS      Fit  SE Fit  Residual  St Resid
 11  2771.10  2142.08   87.23    629.02      2.40 R
 23  1228.90  2142.08   87.23   -913.18     -3.49 R
 35  1249.60  2142.08   87.23   -892.48     -3.41 R

R denotes an observation with a large standardized residual.
```



Adhesion performance
-- HDSS result analysis





- RT SS have such significant main effect with L/F and paste type, and the interaction are also very significant.
- Residual plot show the residual matching the criteria of random distribution, symmetry zero, fitting balance and no special trend.
- 1) HDSS compared by paste:Competitor >ABP8142B;
  2) HDSS compared by L/F: PPF>Cu>BT

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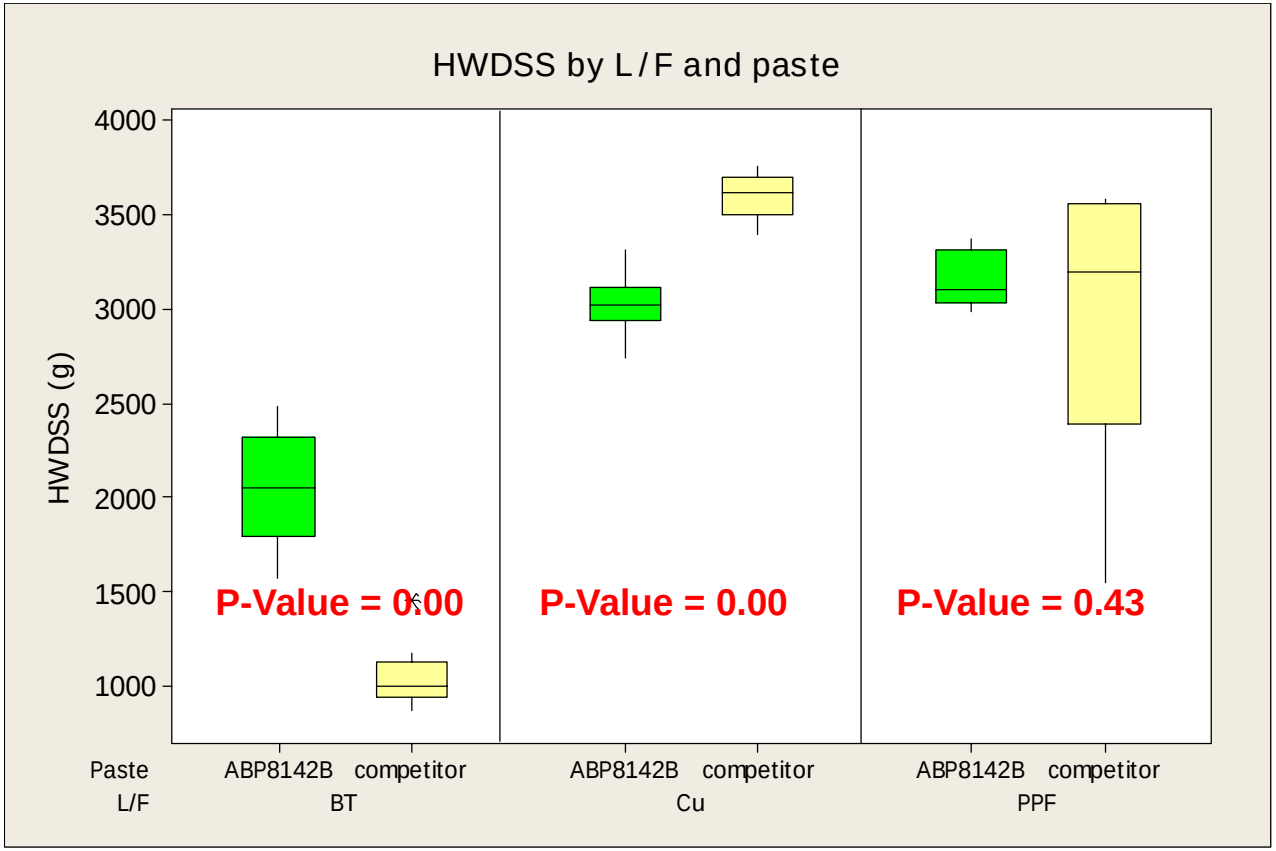
Adhesion compared

-- HWDSS results analysis



- BT: ABP8142B>Competitor;
- Cu L/F: Competitor >ABP8142B;
- PPF L/F: ABP8142B≈ Competitor;

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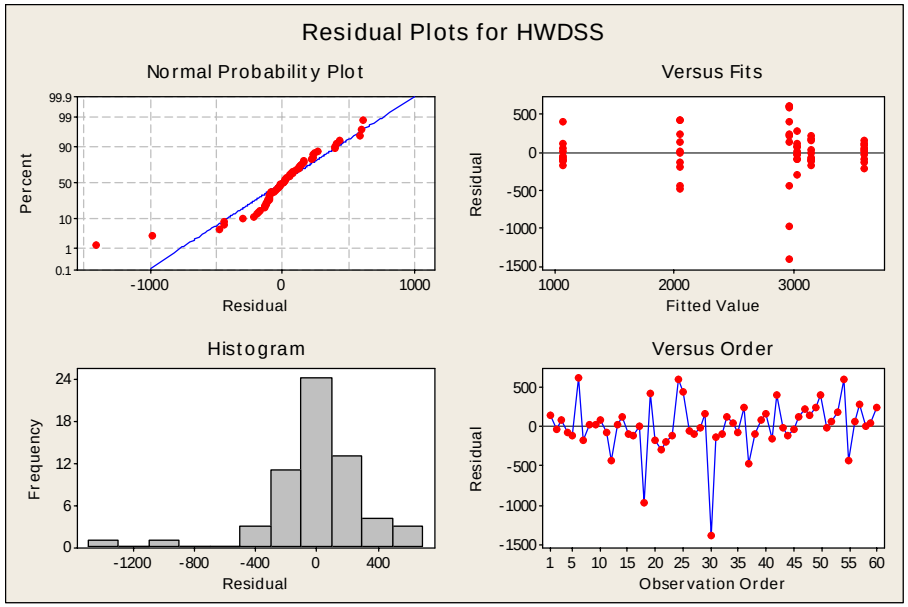
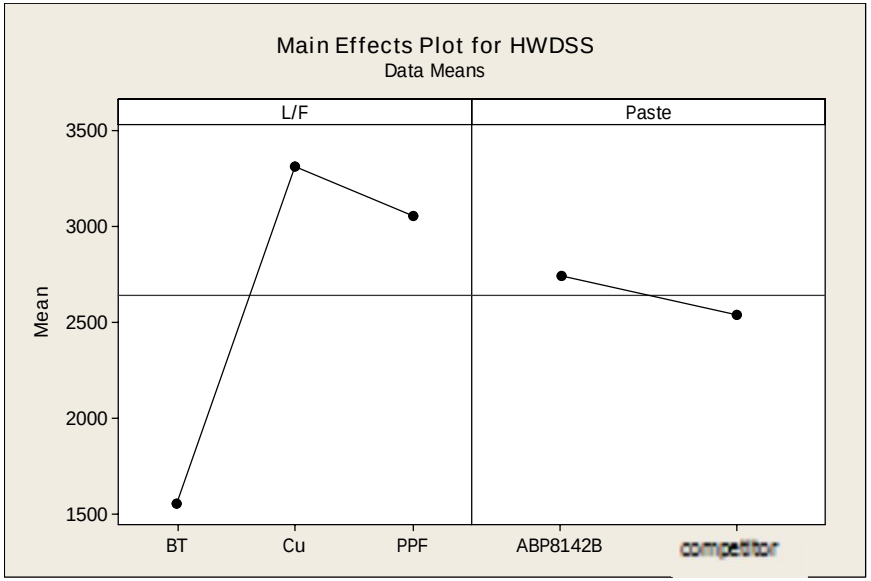
Adhesion performance
-- HWDSS result analysis

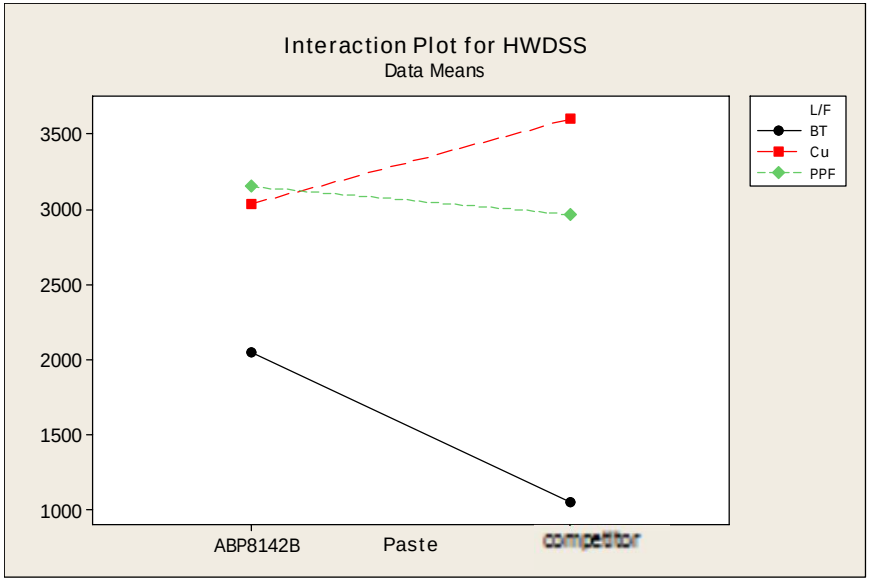
General Linear Model: HWDSS versus L/F, Paste

```
Factor   Type   Levels  Values
L/F      fixed       3  BT, Cu, PPF
Paste    fixed       2  ABP8142B, competitor

Analysis of Variance for HWDSS, using Adjusted SS for Tests
Source      DF    Seq SS    Adj SS    Adj MS       F      P
L/F          2  36248691  36248691  18124345  158.24  0.000
Paste        1    622079    622079    622079    5.43  0.024
L/F*Paste    2   6036479   6036479   3018240   26.35  0.000
Error       54   6185193   6185193    114541
Total       59  49092443

S = 338.438   R-Sq = 87.40%   R-Sq(adj) = 86.23%

Unusual Observations for HWDSS

Obs    HWDSS      Fit  SE Fit  Residual  St Resid
 18  1981.80  2964.54  107.02   -982.74     -3.06 R
 30  1558.50  2964.54  107.02  -1406.04     -4.38 R

R denotes an observation with a large standardized residual.
```



Adhesion performance
-- HWDSS result analysis





- RT SS have such significant main effect with L/F and paste type, and the interaction are also very significant.
- Residual plot show the residual matching the criteria of random distribution, symmetry zero, fitting balance and no special trend.
- 1) HWDSS compared by paste: ABP8142B > Competitor;
  2) HWDSS compared by L/F: Cu>PPF>BT

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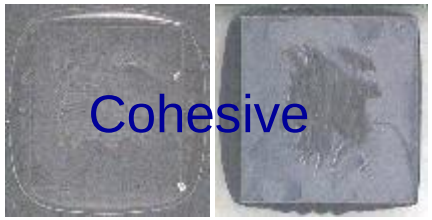
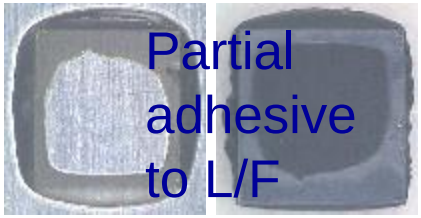
Adhesion performance

-- Fail mode-ABP8142B

ABP8142B	RT	HDSS	HWDSS
BT	 Cohesive	 Cohesive	 Cohesive
Cu	 Cohesive	 Cohesive	 Adhesive to L/F
PPF	 Cohesive	 Partial adhesive to L/F	 Partial adhesive to L/F

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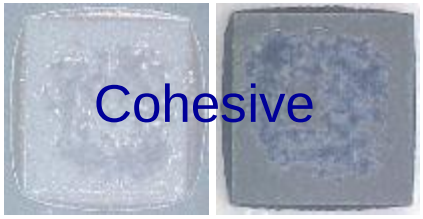
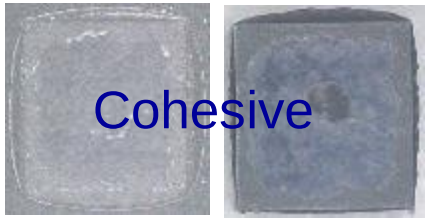
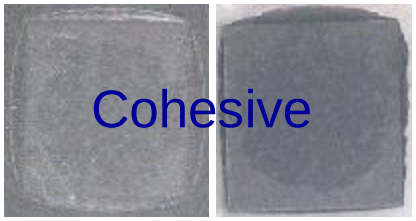
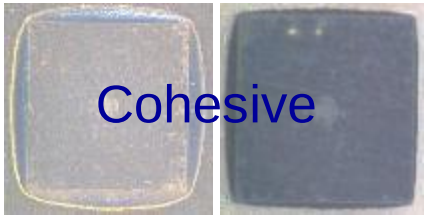
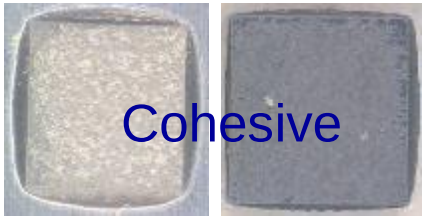
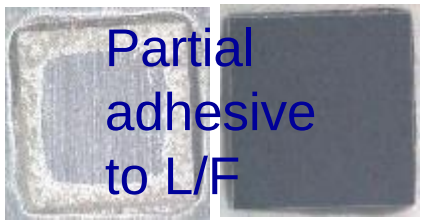
Adhesion performance

-- Fail mode- Competitor

Competitor	RT	HDSS	HWDSS
BT			
Cu			
PPF			

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Adhesion performance
-- Summary

Based on DOE adhesion data analysis results:

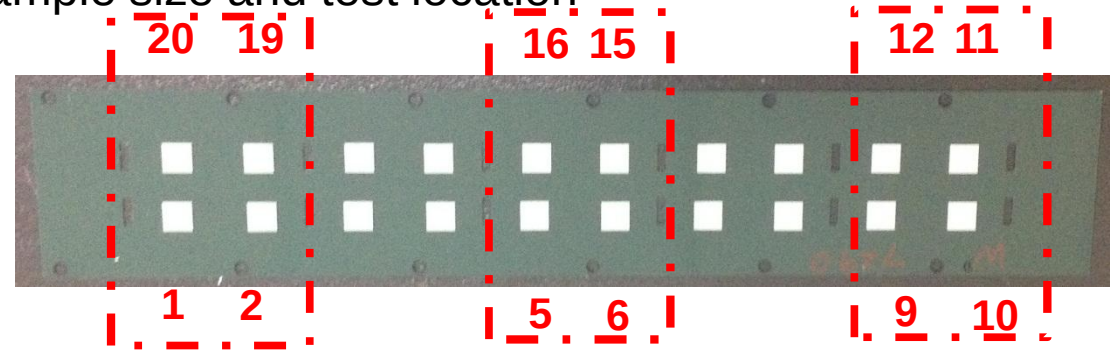
- RT DSS: ABP8142B>Competitor;
- HDSS: Competitor>ABP8142B
- HWDSS: ABP8142B>Competitor

L/F	RT	HDSS	HWDSS
BT	ABP8142B>Competitor	Competitor >ABP8142B	ABP8142B>Competitor
Cu	ABP8142B>Competitor	ABP8142B≈ Competitor	Competitor >ABP8142B
PPF	ABP8142B ≈ Competitor	Competitor >ABP8142B	ABP8142B≈ Competitor

Warpage performance

Warpage
-- Test Plan

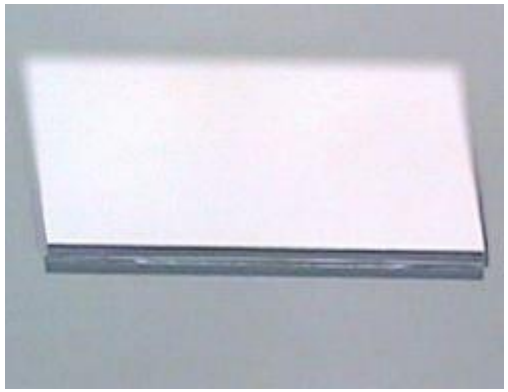
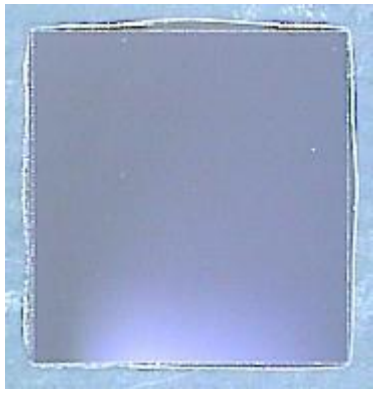
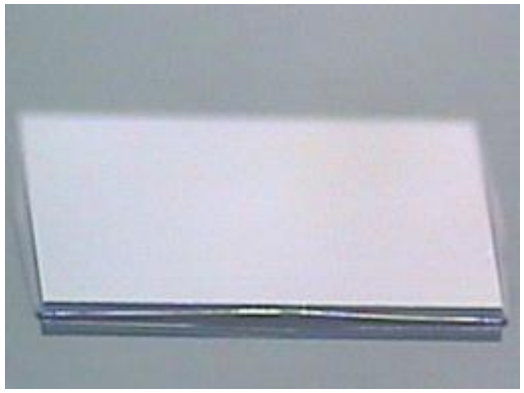
- Warpage is an indicator of package stress which is a key factor for reliability. Normally, lower warpage means lower stress
  - Test Sample: ABP8142B & Competitor
  - Lead frame: Henkel BT substrate: 0.26mm thickness;
  - Sample size and test location



  - Die: 5X5mm, 6mil thickness
  - Curing: 30 min ramp up to 150℃, keep 30 min, Air oven

Warpage

-- Sample prepared: BLT, fillet checked

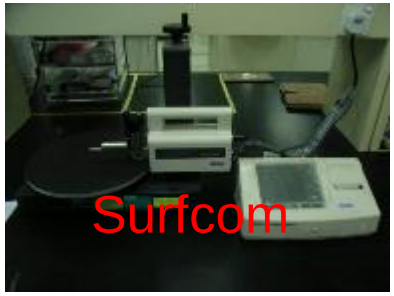
	Top view	Side view
ABP8142B		
Competitor		

- BLT control: ~25um

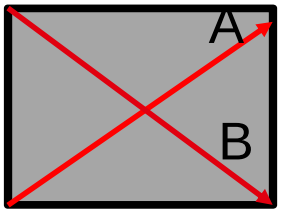
Warpage

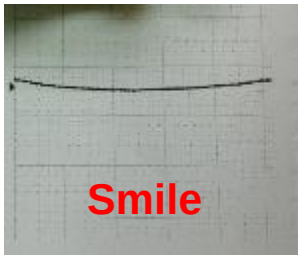
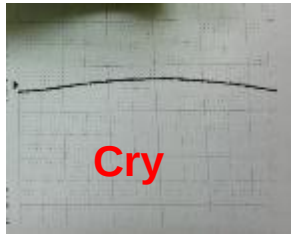
-- Test machine, method and warpage results trace

2D



Test 2 line



Paste	Trace
ABP8142B	
Competitor	

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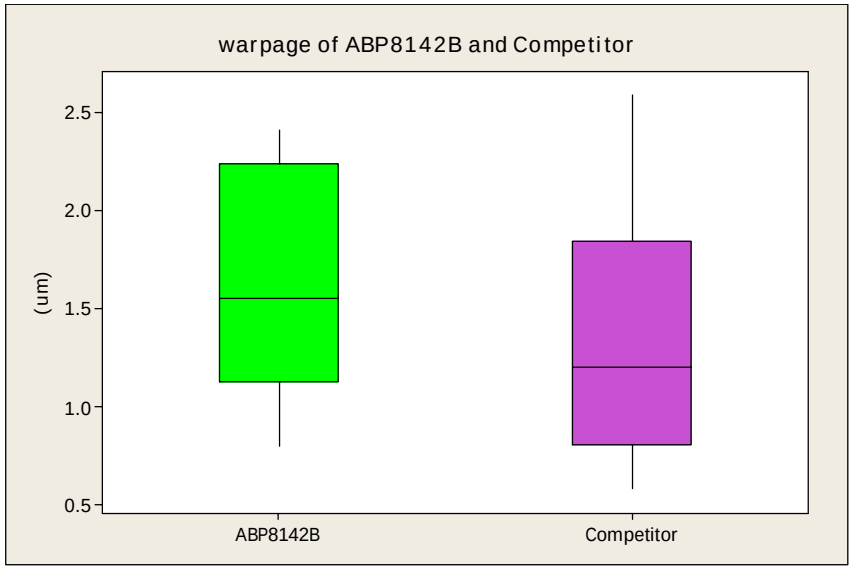
Warpage

-- Results analysis: data analysis: warpage from max data by A and B

Two-Sample T-Test and CI: ABP8142B, Competitor

```
Two-sample T for ABP8142B vs Competitor
             N   Mean  StDev  SE Mean
ABP8142B    12  1.649  0.562     0.16
Competitor  12  1.374  0.648     0.19
Difference = mu (ABP8142B) - mu (Competitor)
Estimate for difference:  0.275
95% CI for difference:  (-0.240, 0.790)
T-Test of difference = 0 (vs not =): T-Value = 1.11  P-Value = 0.280  DF = 21
```



- ABP8142B and Competitor have no significant difference

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Warpage performance
-- Summary

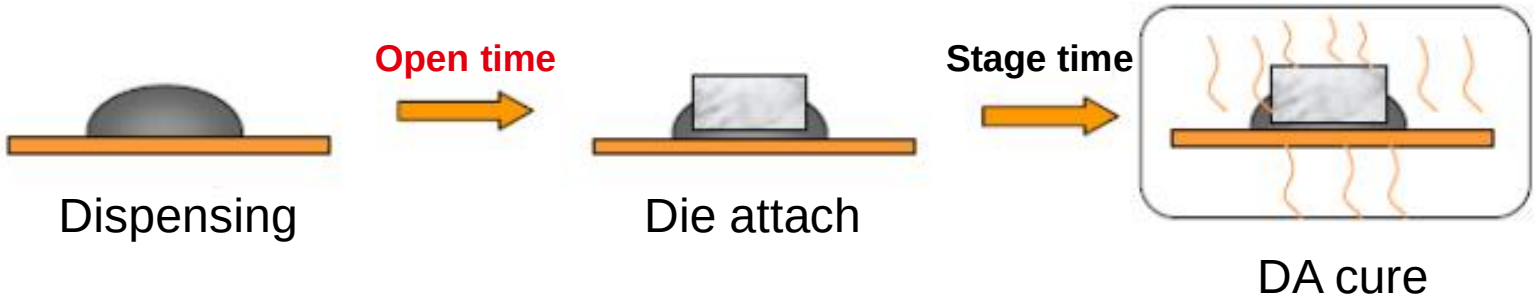
- ABP8142B and competitor have no significant difference on warpage performance

Open Time and Stage Time Study

Open Time and Stage Time Study

-- Open Time

- Open time: The time after dispending and before die attach, at that time, the paste is open to the environment



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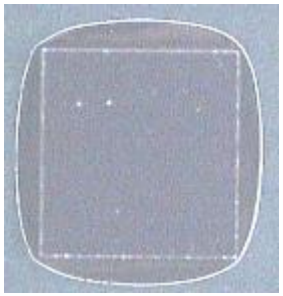
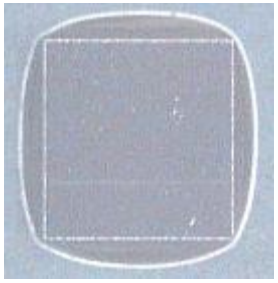
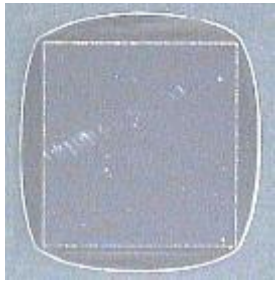
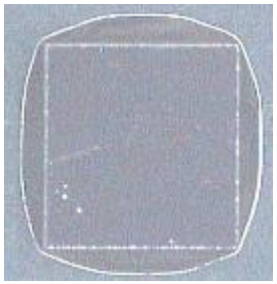
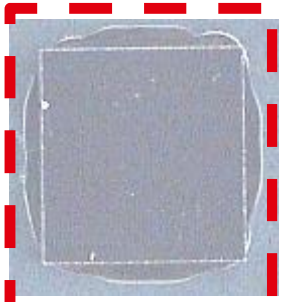
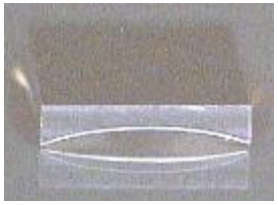
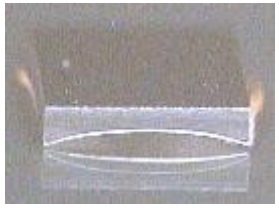
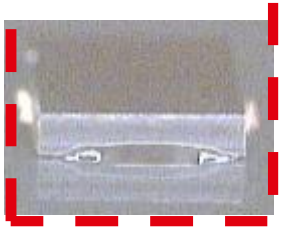
Open Time and Stage Time Study

-- Open Time ABP8142B

Open Time	0min	30mins	1hrs	2hrs	4hrs
Top View					
Side View					

- Perfect coverage even after 2 hours open time

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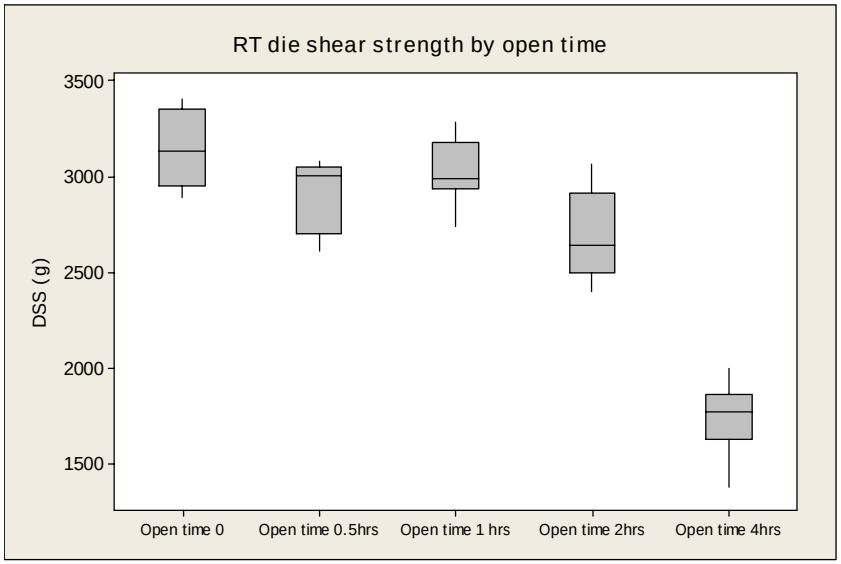
Open Time and Stage Time Study

-- Open Time ABP8142B



One-way ANOVA: Open time 0, Open time 0., Open time 1 , Open time 2h, ...

Source	DF	SS	MS	F	P
Factor	4	10168399	2542100	67.52	0.000
Error	35	1317768	37651		
Total	39	11486167			

S = 194.0 R-Sq = 88.53% R-Sq(adj) = 87.22%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	2000 2500 3000 3500
Open time 0	8	3144.2	193.0	(--*--)
Open time 0.5hrs	8	2913.1	185.4	(--*--)
Open time 1 hrs	8	3028.4	170.7	(--*-)
Open time 2hrs	8	2692.8	228.4	(--*--)
Open time 4hrs	8	1740.6	188.0	(--*--)

Pooled StDev = 194.0

- Die size: 2x2mm die

- There's a trend that the RT die shear strength will drop as time grows, and after 4 hours open time, the influence will become significant

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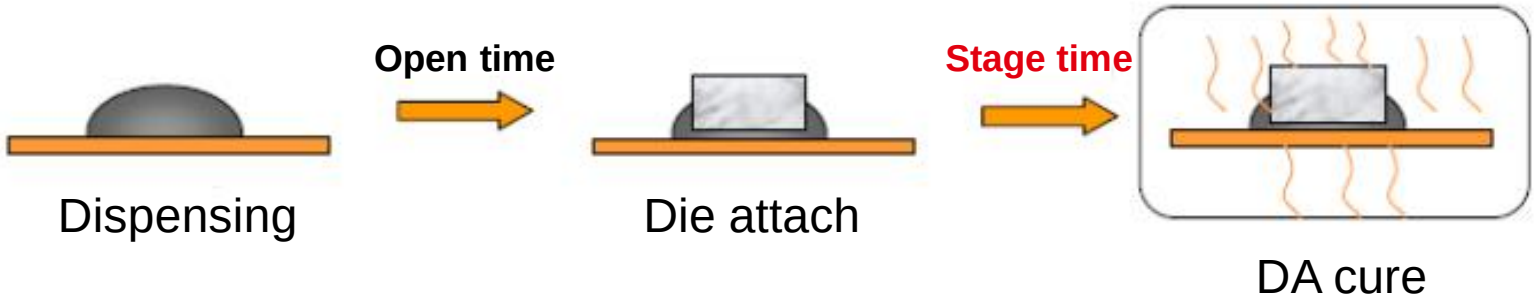
Open Time and Stage Time Study

-- Stage Time

- Stage time: After die attach, it will take some time to put the packages into oven, and the time is called stage time



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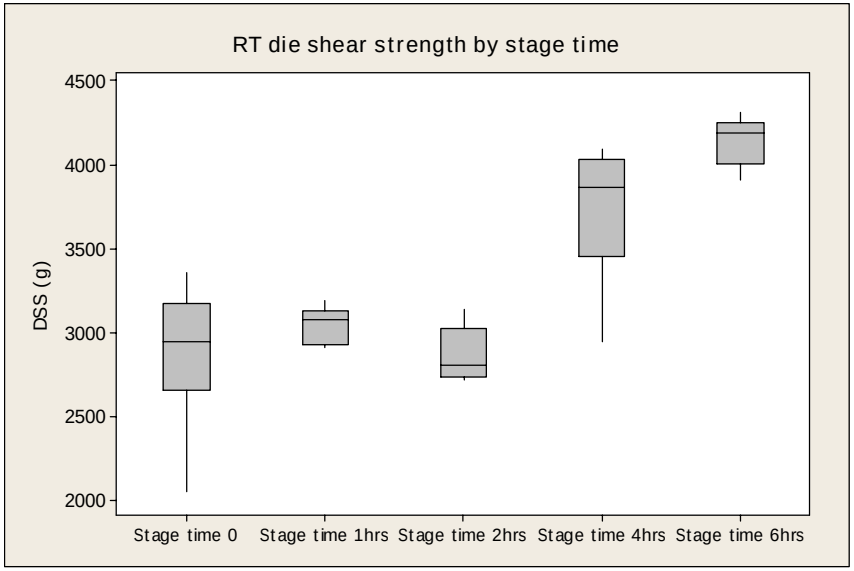
Open Time and Stage Time Study

-- Stage Time-ABP8142B



One-way ANOVA: Stage time 0, Stage time 1, Stage time 2, Stage time 4, ...

Source	DF	SS	MS	F	P
Factor	4	10555813	2638953	34.62	0.000
Error	35	2667829	76224		
Total	39	13223642			

S = 276.1 R-Sq = 79.83% R-Sq(adj) = 77.52%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	----------+---------+---------+---------+--
Stage time 0	8	2872.4	409.9	(---*---)
Stage time 1hrs	8	3048.5	102.6	(---*---)
Stage time 2hrs	8	2866.0	157.3	(---*---)
Stage time 4hrs	8	3715.6	396.4	(---*---)
Stage time 6hrs	8	4146.6	143.9	(---*---)

3000 3500 4000 4500

Pooled StDev = 276.1

- Die size: 2x2mm die

- No adhesion decrease after 6 hours stage time

Open and stage time Performance
-- Summary

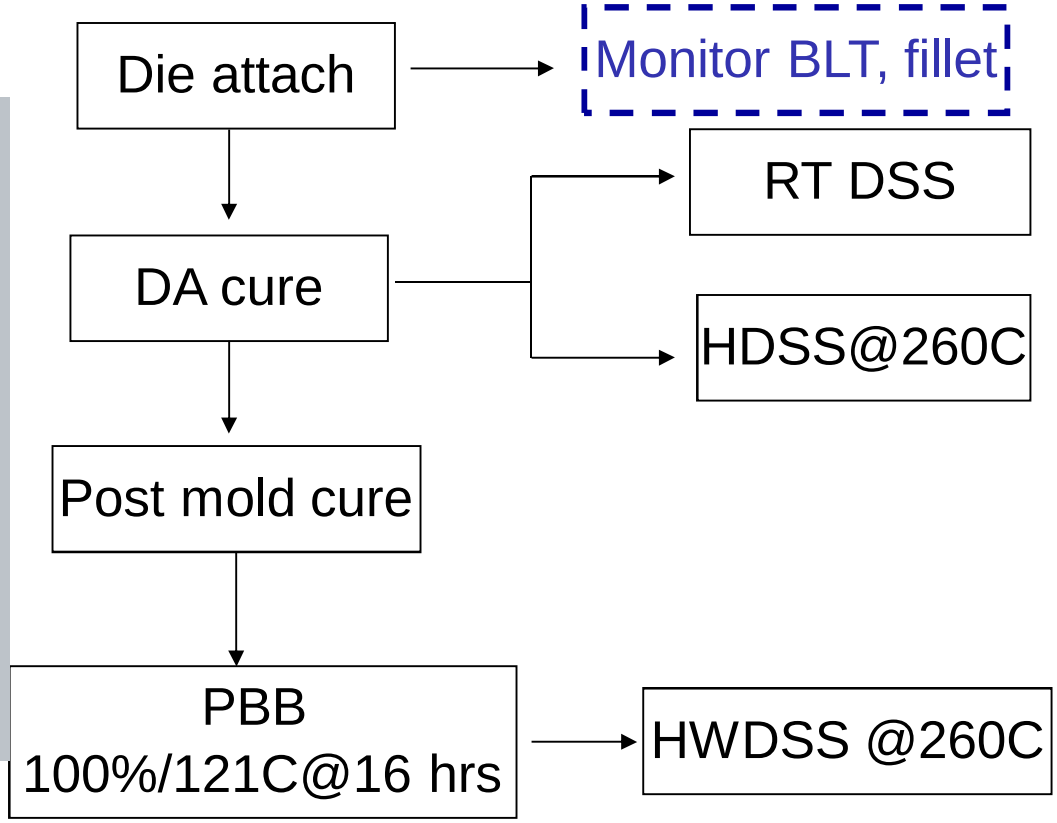
- Open Time: ABP8142B after 4 hours open time, adhesion have significant drop, so open time at least 2 hours;
- Stage Time: ABP8142B have no adhesion decrease even after 6 hours stage time

Oven Cure Environment Study
Air Vs N_2

Oven Cure Environment Study
-- Plan

- **Environment: Air Vs N_2**
- Adhesion compared: RT, HDSS and HWDSS
- L/F: Henkel in-house BT Cu/PPF L/F
- Die thickness:15mil
- Curing profile: 30min ramp up to the setted temperature, hold 30min
- PMC: 175 ℃, 4 hours
- Sample size: 10 unites/leg

- Test flow



HDSS: hot die shear strength

HWDSS: hot wet die shear strength, after parr bomb.

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Oven Cure Environment Study
-- Adhesion compared

Two-Sample T-Test and CI: Air RT, N2 RT

```
Two-sample T for Air RT vs N2 RT
         N  Mean  StDev  SE Mean
Air RT  10  3607    435      137
N2 RT   10  3098    428       13
Difference = mu (Air RT) - mu (N2 RT)
Estimate for difference:  509
95% CI for difference:  (103, 916)
T-Test of difference = 0 (vs not =): T-Value = 2.64  P-Value = 0.017  DF = 17
```

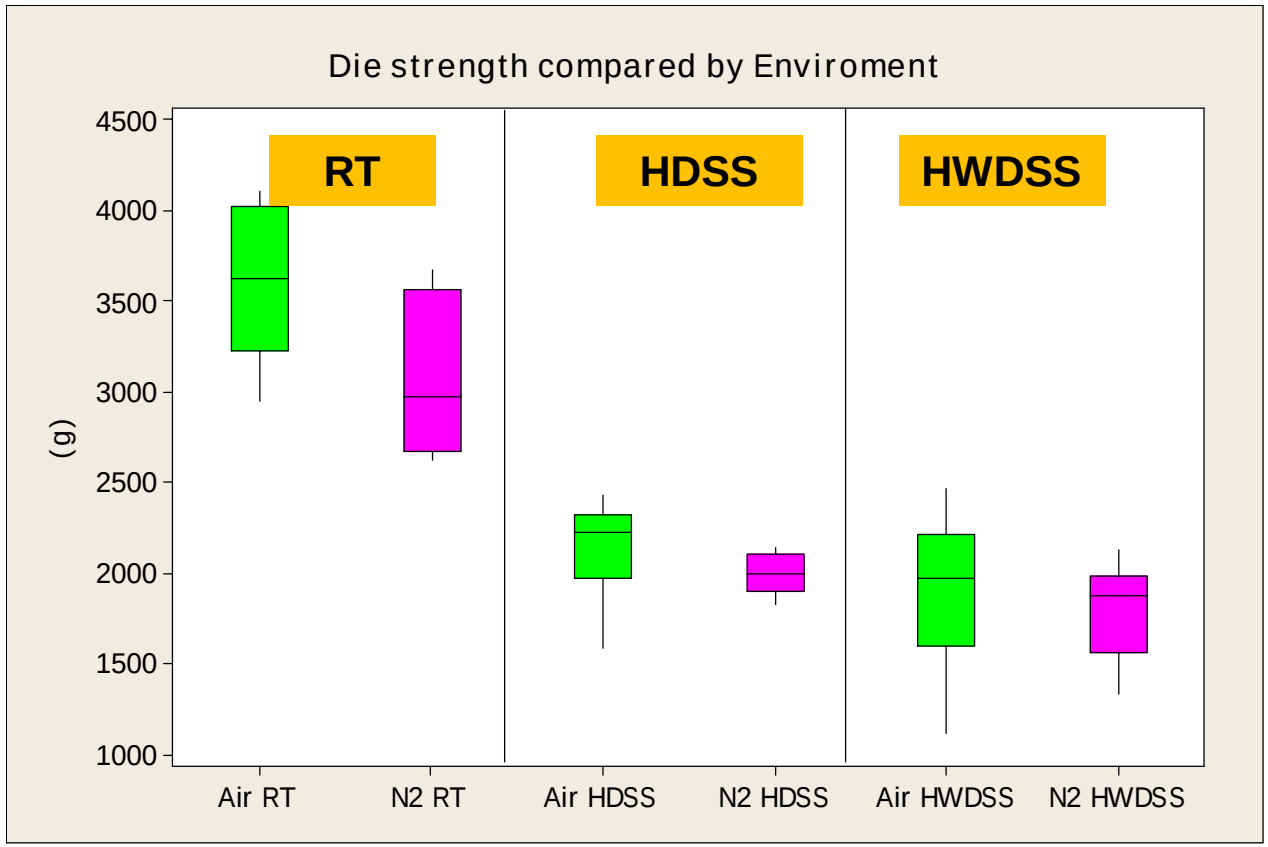
Two-Sample T-Test and CI: Air HDSS, N2 HDSS

```
Two-sample T for Air HDSS vs N2 HDSS
                          SE
           N  Mean  StDev  Mean
Air HDSS  10  2132    276    87
N2 HDSS   10  1998    103    33
Difference = mu (Air HDSS) - mu (N2 HDSS)
Estimate for difference:  133.6
95% CI for difference:  (-71.7, 339.0)
T-Test of difference = 0 (vs not =): T-Value = 1.43  P-Value = 0.180  DF = 11
```

Two-Sample T-Test and CI: Air HWDSS, N2 HWDSS

```
Two-sample T for Air HWDSS vs N2 HWDSS
            N  Mean  StDev  SE Mean
Air HWDSS  10  1911    394      125
N2 HWDSS   10  1791    281       89
Difference = mu (Air HWDSS) - mu (N2 HWDSS)
Estimate for difference:  120
95% CI for difference:  (-204, 445)
T-Test of difference = 0 (vs not =): T-Value = 0.78  P-Value = 0.444  DF = 16
```

Oven Cure Environment Study
-- Adhesion compared



Oven Cure Environment Study

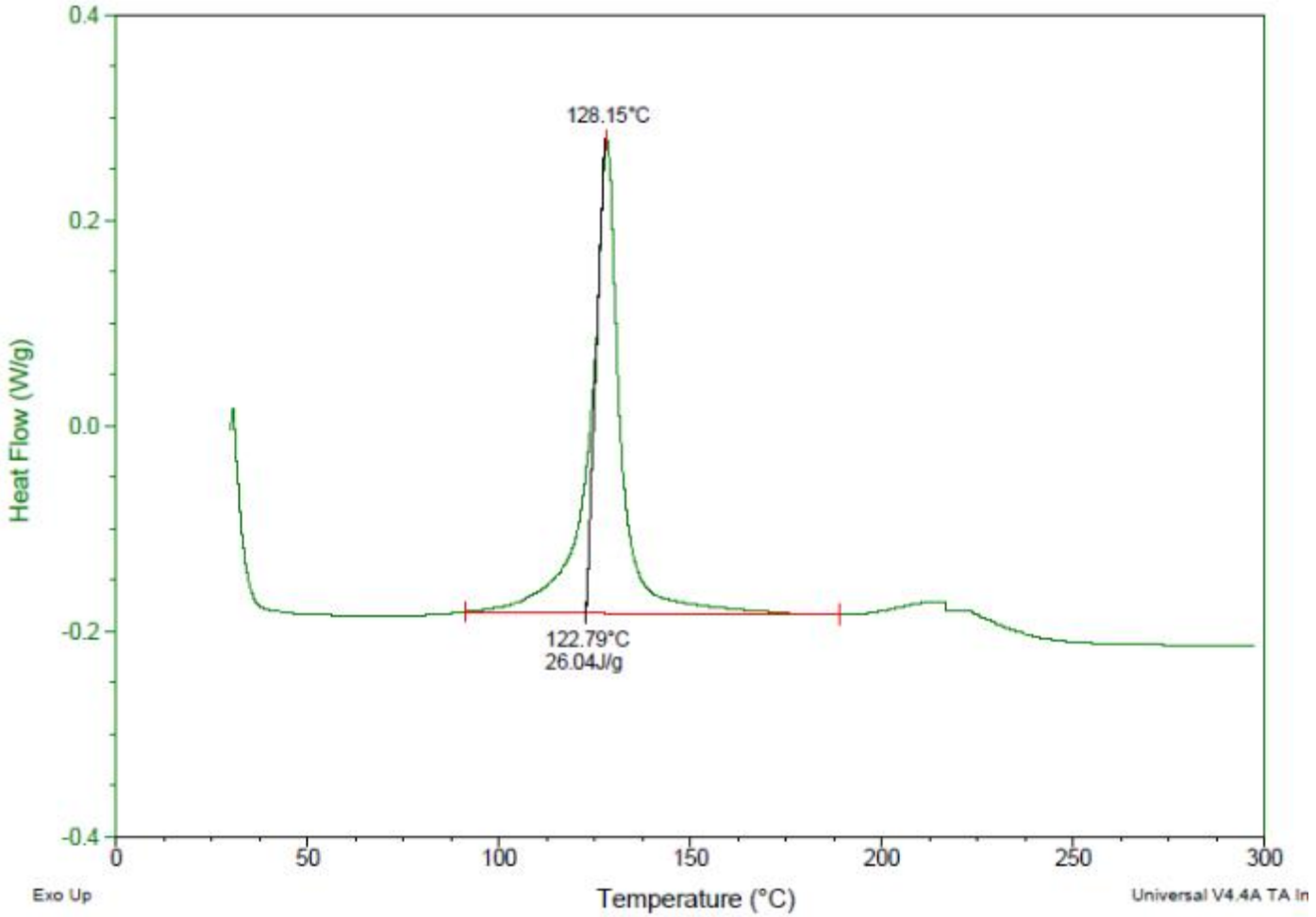
-- Summary

- ABP8142B Air environment is better than N2 environment, based on adhesion test results:
  - ✓ RT DSS: Air > N2
  - ✓ HDSS: Air ≈ N2
  - ✓ HWDSS: Air ≈ N2

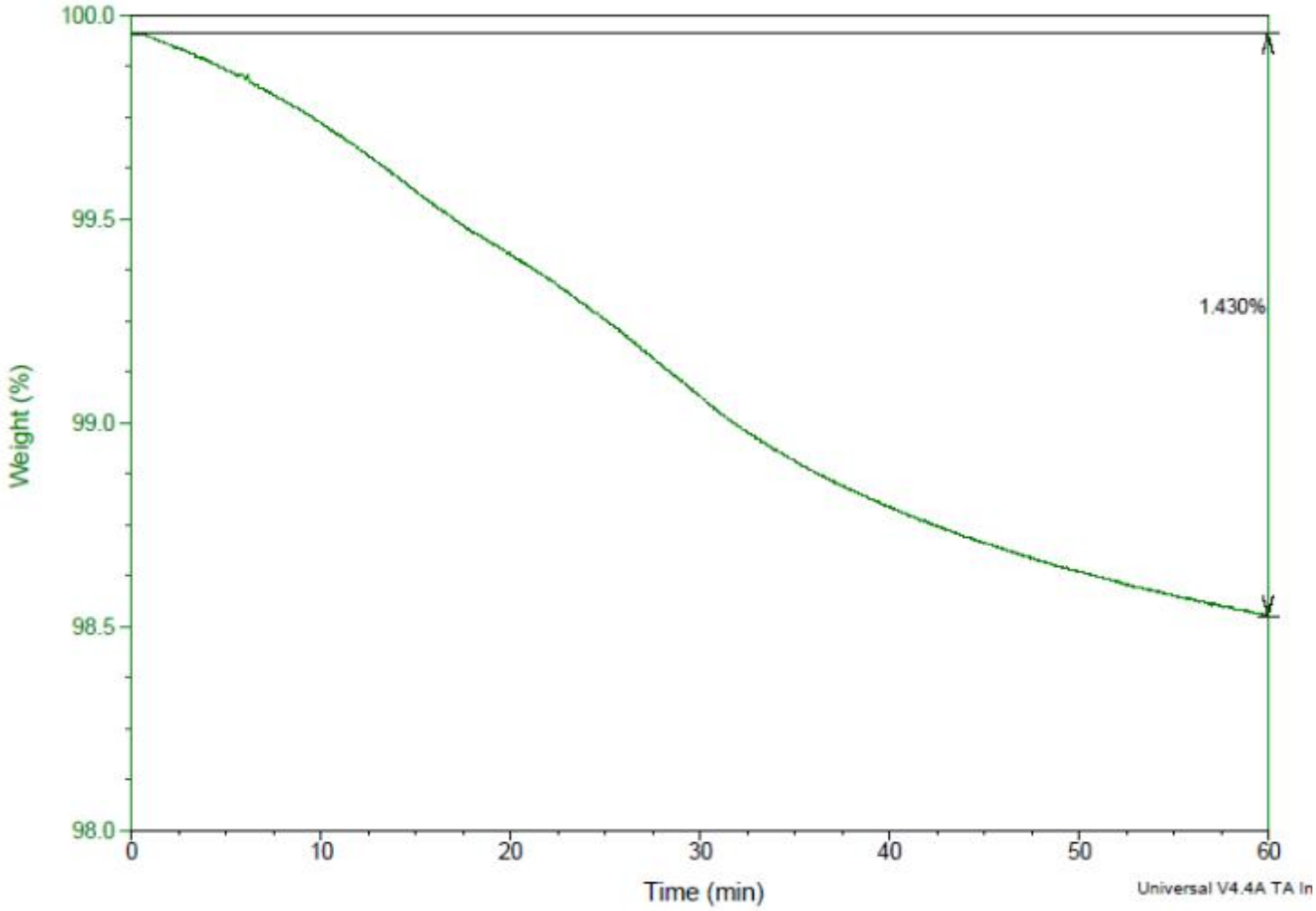
- ABP8142B recommend to cure in Air environment

Appendix

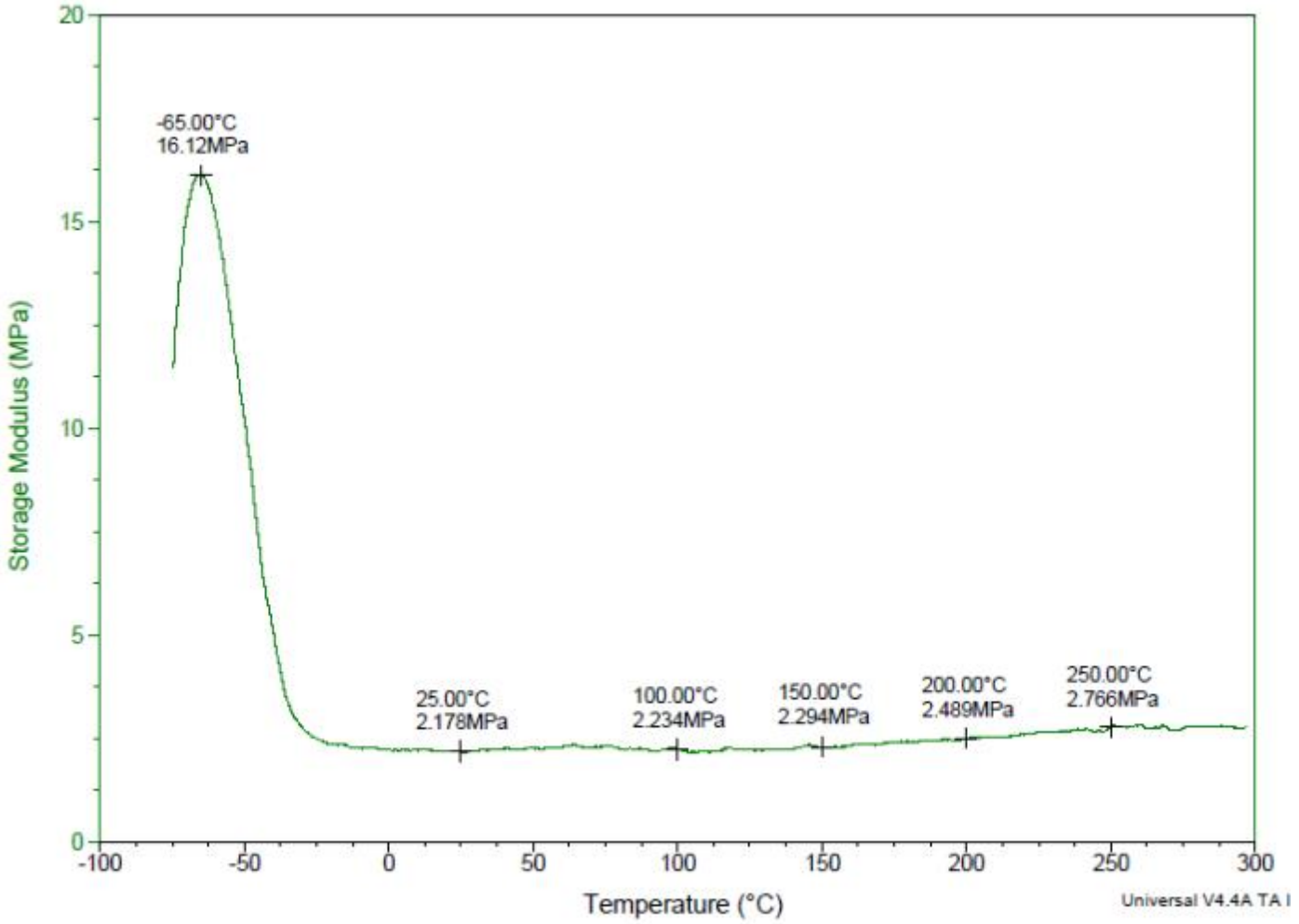
Appendix
-- DSC-ABP8142B



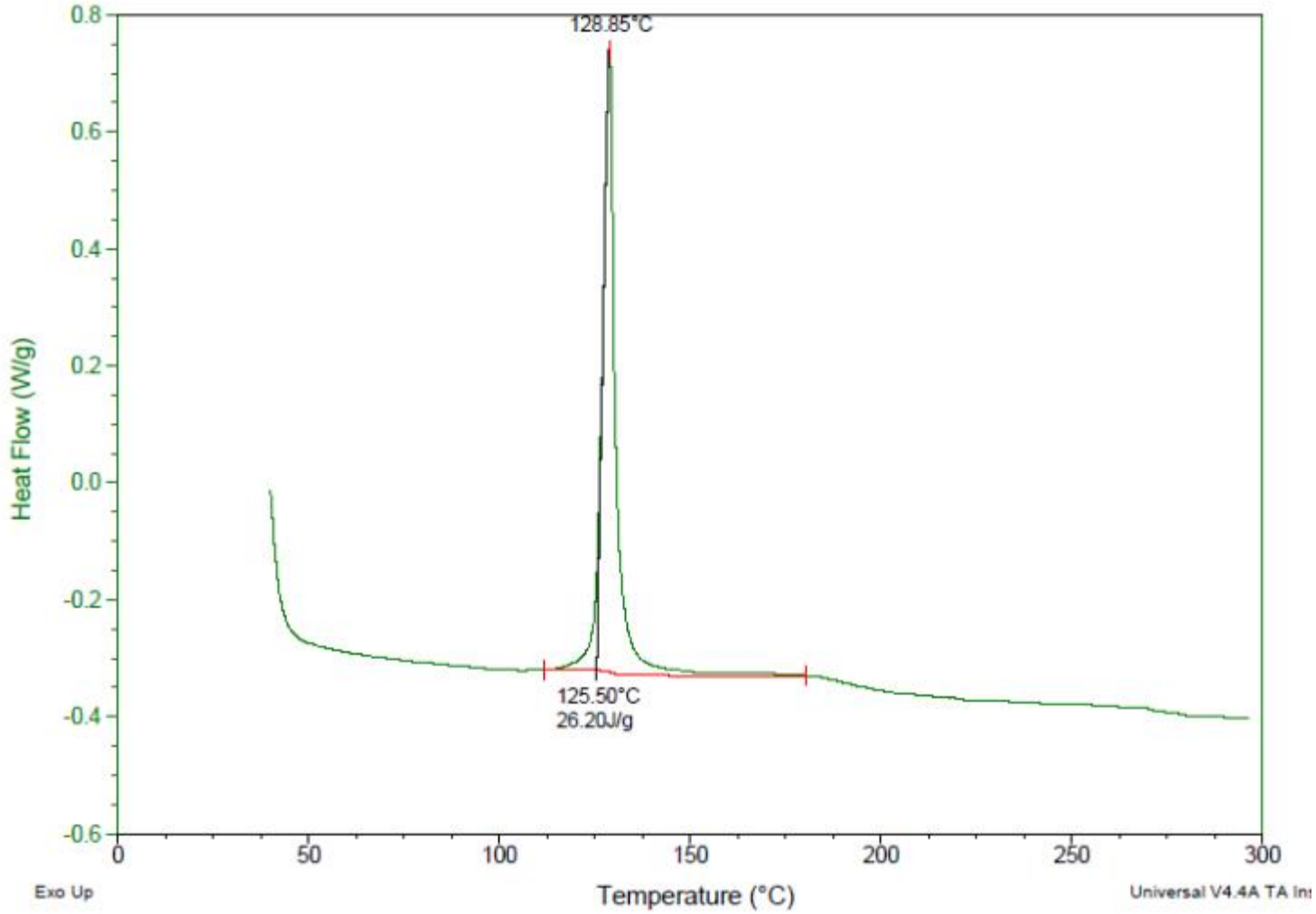
Appendix
-- TGA-ABP8142B



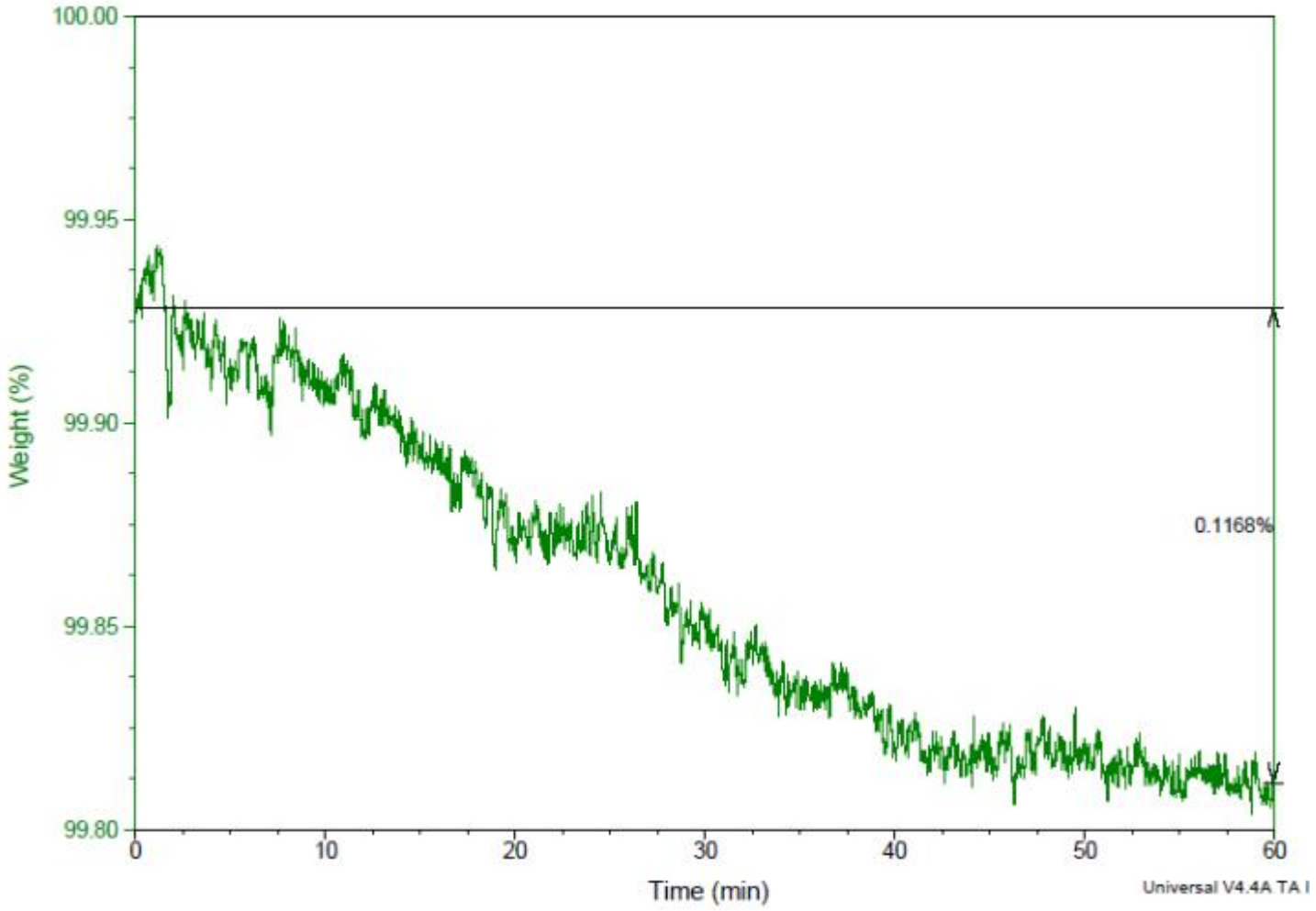
Appendix
-- DMTA-ABP8142B



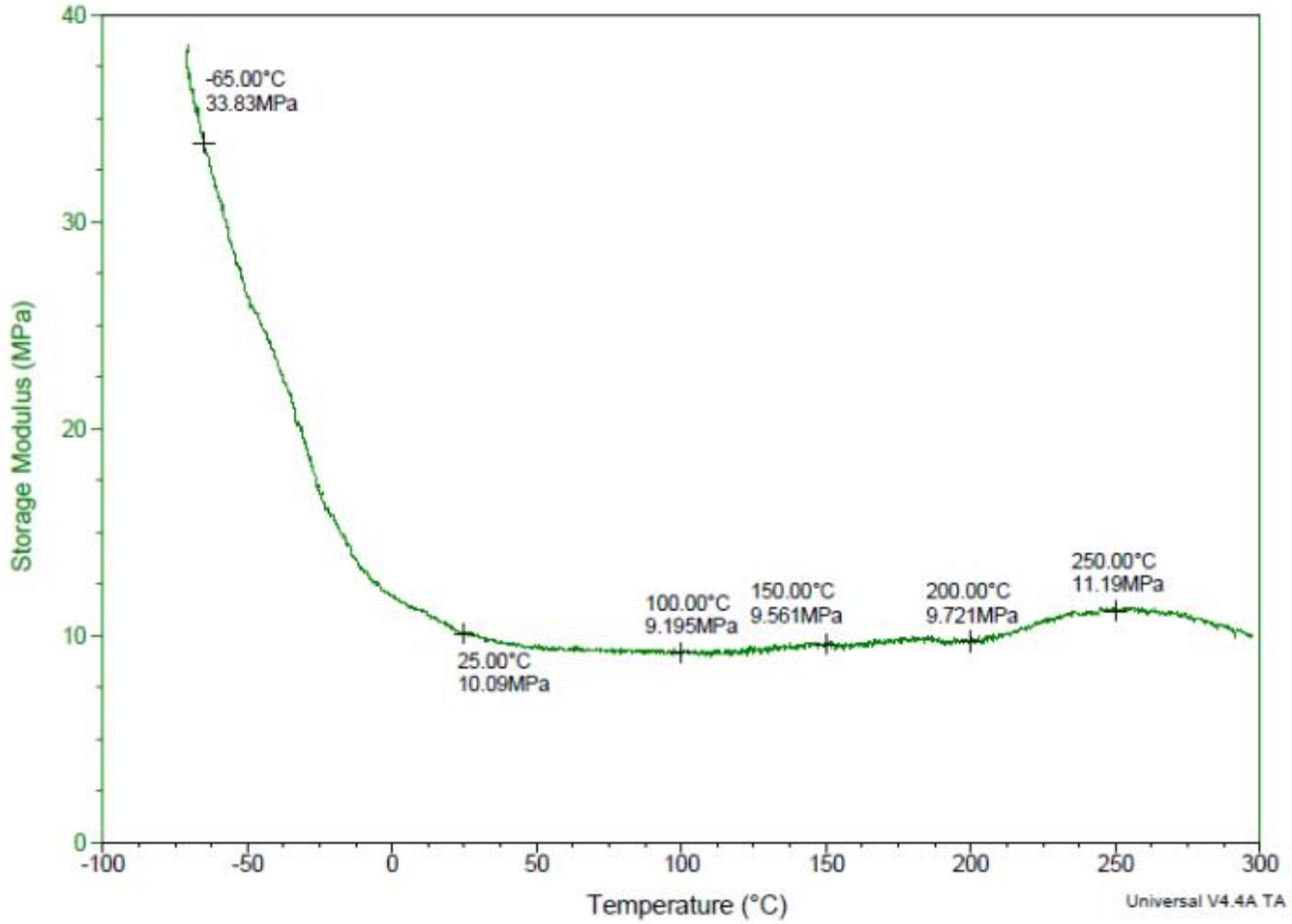
Appendix
-- DSC- Competitor



Appendix
-- TGA- Competitor



Appendix
-- DMTA- Competitor



Thank you!