LOCTITE ABLESTIK ABP 8068TB Data Package

Semi-sintering Die Attach Paste

Henkel Electronic Materials

WGQ/Apr 2018

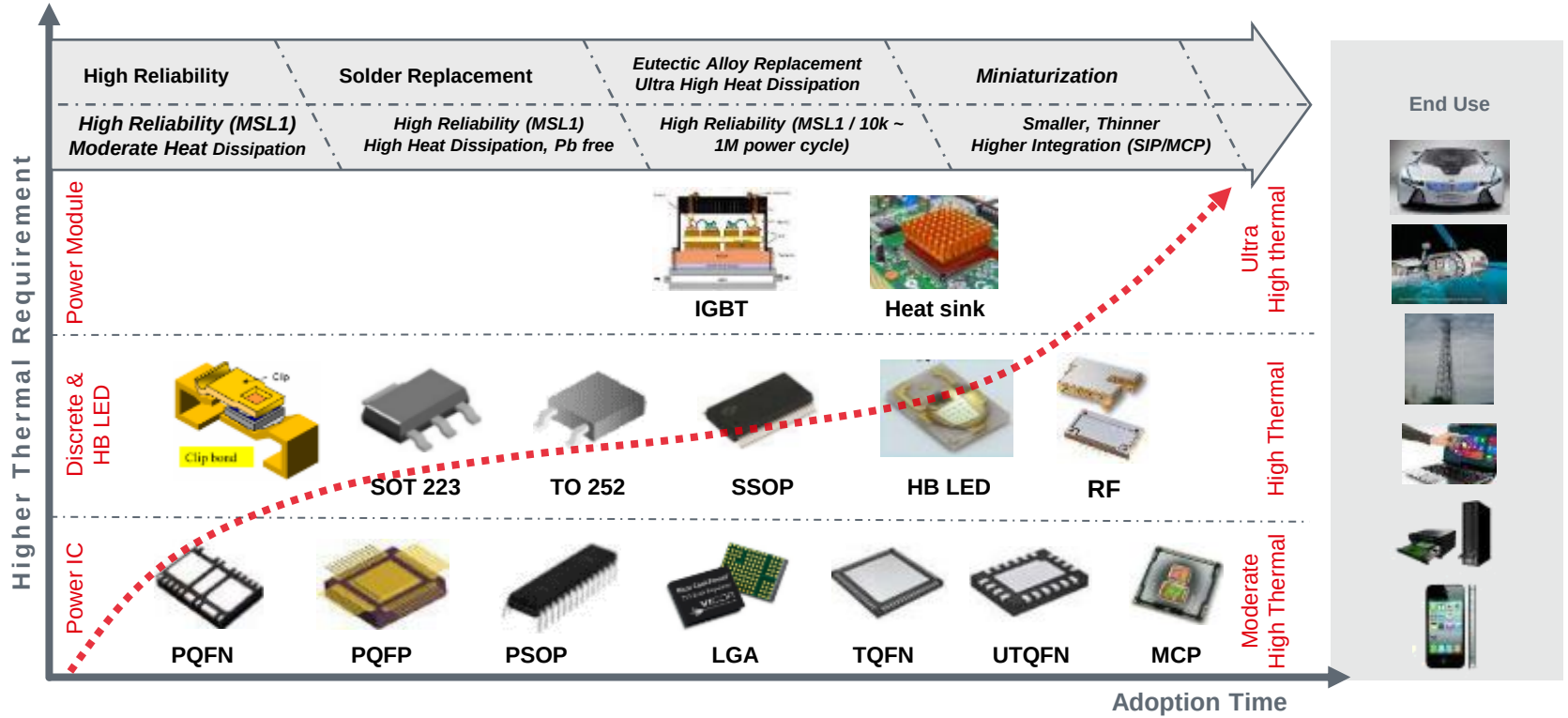
Agenda

- High Thermal DA Introduction
- ABP 8068TB Introduction
- Workability
- Void & Adhesion
- In Package Thermal Resistance & Reliability

High Thermal DA Introduction

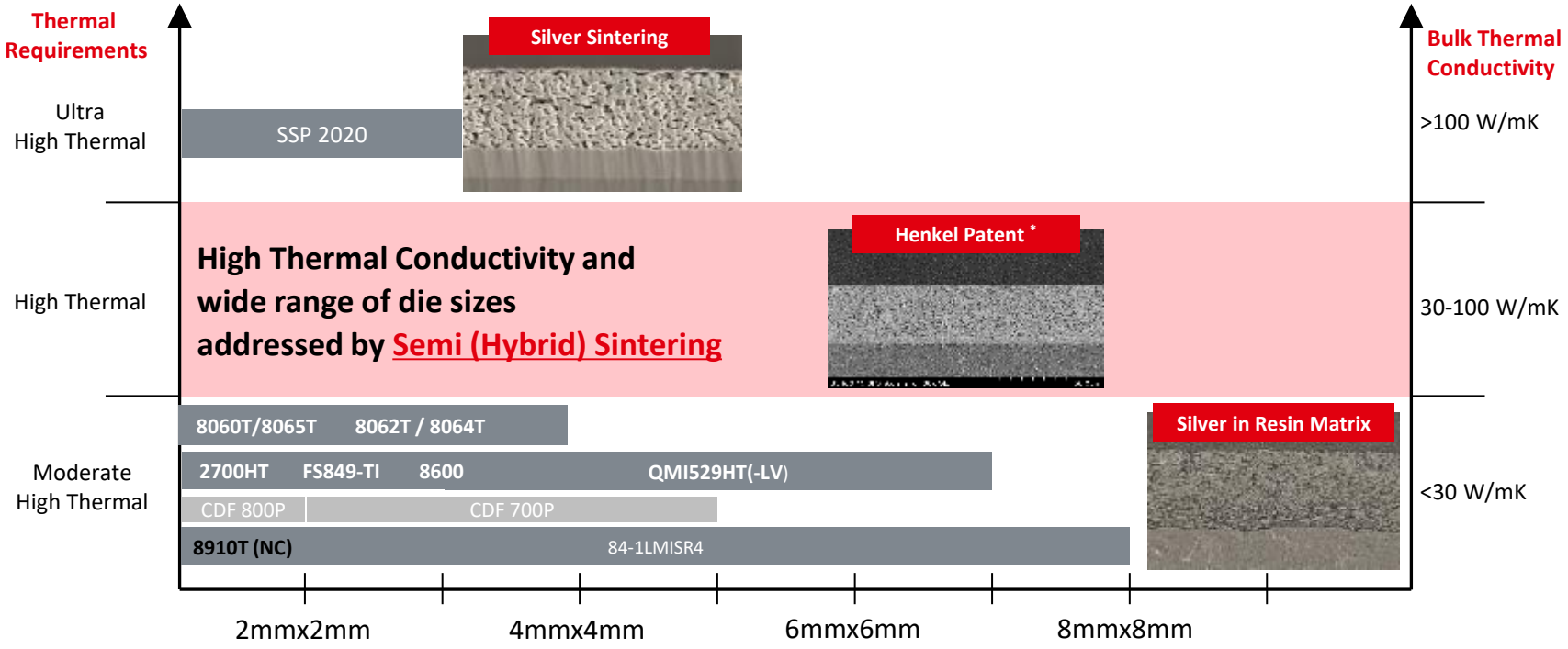
High Thermal DA Introduction

Applications for High Thermal Die Attach Pastes



High Thermal DA Introduction

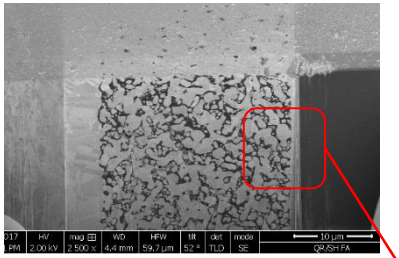
Henkel Solution



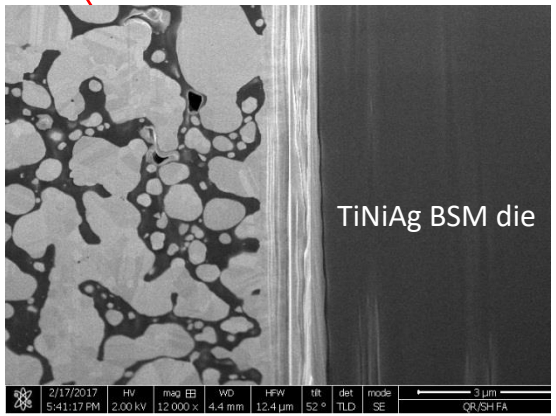
High Thermal DA Introduction

Difference of pure sintering & semi-sintering

ABP 8068TB cured @ 175°C

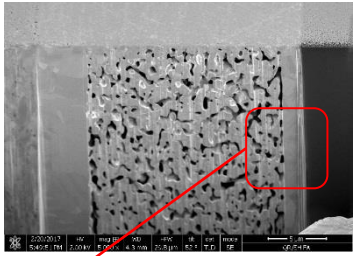


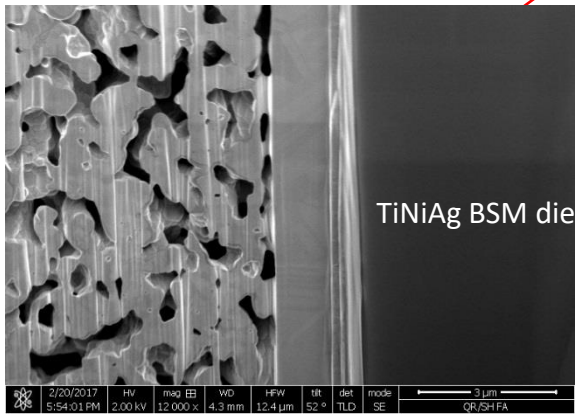
- Lower temperature sintering, no need of high pressure and temperature for sintering
- Void free bond lines



Full Sintering cured @ 220°C

- High temperature and pressure required for sintering
- Porous bond lines





ABP 8068TB Introduction

ABP 8068TB Introduction

Product Feature

- ABP 8068TB is a semi-sintering die attach paste designed for semiconductor devices which require ultra high thermal conductive adhesive. Typical application is die attach.
- It can provide below benefits for customers:
  - Robust, lead free solder alternative
  - Lower temperature sintering – achieve pressure less sintering at lower temperature of 175°C to 200°C
  - Best in-class electrical and thermal performance
    - Bulk thermal conductivity up to 100 W/m·K
    - Low-in-package thermal resistance (R_{th}) ~ 0.5 K/W
  - It can be applied to a wide range of die size from 0.5x0.5 to 8x8mm regardless of die back side metallization – Ag, Au or TiNiAg
  - Processing similar to standard die attach pastes
  - Excellent workability, exceptional dispensing and printing
    - Longer work life of 16 hrs.
    - Stable open time of 2 hours
  - Robust adhesion
    - It achieves high adhesion on different lead frame finish including PPF, Au, Ag and bare Cu surface.

ABP 8068TB Introduction

Typical Technical Data

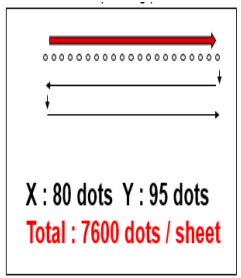
ABP 8068TB Typical Technical Data			
Technology	Semi-Sintering	Recommended Cure profile <5*5mm	20min ramp to 130ºC,hold 0.5-1h; +15min ramp to 200ºC, hold 2h.
		Recommended Cure profile >5*5mm	20min ramp to 130ºC,hold 2h; +15min ramp to 200ºC, hold 2h.
Chemistry	Epoxy	Weight Loss on Cure, by TGA	4.0%
Filler type	Silver	Bulk Thermal Conductivity (W/mK)	100
Density, g/ml	5.6	Volume Resistivity (Ohm·cm)	7×10^{-6}
Viscosity @ 25ºC (cps), 5rpm, CP51	11,500	Tg by TMA	25 ºC
Thixotropic Index, 0.5rpm/5rpm	5.5	CTE1 (ppm/ºC)	25
Open time, 1x1mm die	2hrs	CTE2 (ppm/ºC)	103
Stage time, 3x3mm die	>=4hrs	Modulus @25ºC (GPa)	12.5
Work Life @ 25ºC	16hrs	Modulus @150ºC (GPa)	1.1
Recommended Storage Temperature	-40 ºC	Modulus @250ºC (GPa)	0.65
Storage Life (@ -40ºC)	1year	Tg by DMA	66 ºC
Elongation @ break, RT	5.0%		

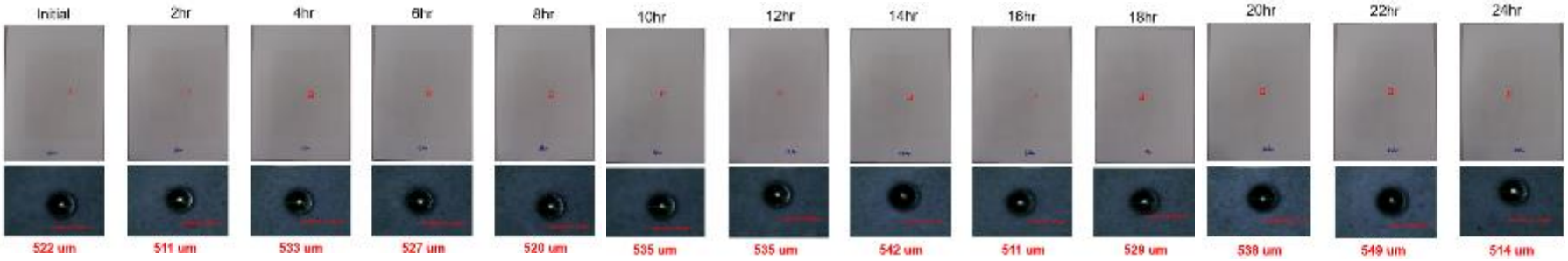
Manufacturability Test

Dispensing Performance
Continuous “dot” dispense

Condition for Dot Dispensing :

CAMALOT – pneumatic dispenser
- Air pressure @ 6 psi
- Musashi conical needle (HN), ID: 200um
- Continuous dot dispensing on OHP film (A4 size) ~500um diameter
- Total dispense : ~100K dots



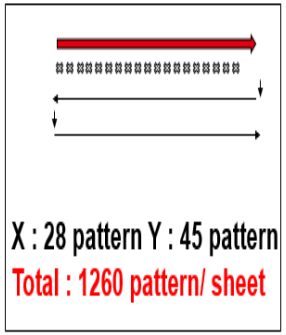


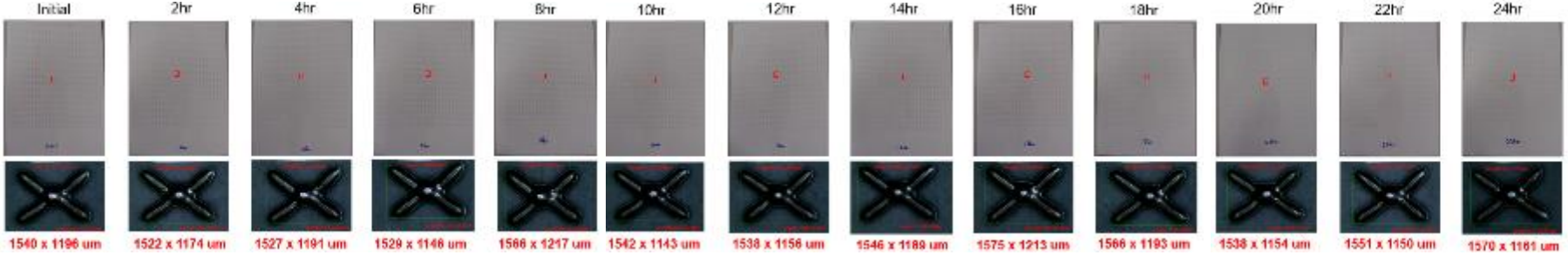
- No missing dot observed up to even 24hrs

Dispensing Performance
Continuous “X pattern” dispense

Condition for X Pattern Dispensing :

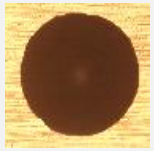
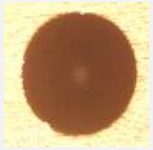
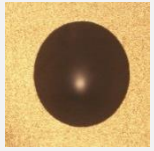
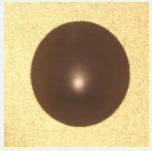
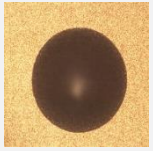
Musashi Super ΣCM II – pneumatic dispenser
- Air pressure @ 6.5 psi
- Musashi conical needle (HN), ID: 200um
- Continuous dot dispensing on OHP film (A4 size, ~1.5 x 1.1 mm
- Total dispense : ~ 17K pattern





- No missing pattern observed up to even 24hrs
- Consistent volume with continuous dispensing

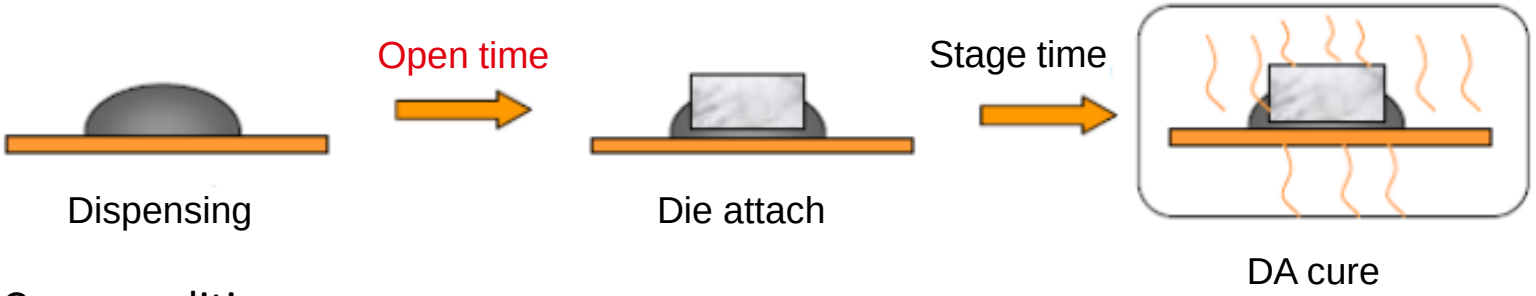
Bleed Performance

	0hr	2hrs	After cured
Ag/Cu			
Cu			
PPF			
Au			

- Good bleed performance on all surface, though slight RBO on Cu surface

Workability
Open Time

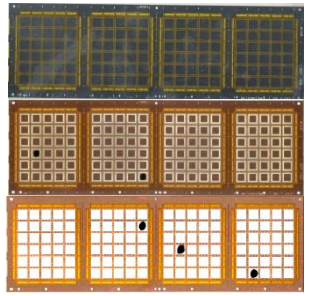
- Open time: The time after dispending before die attach. At that time the paste is open to the environment.



- Cure condition
  - Profile 1 (N2): 20min ramp to 130C, hold 30min + 15min ramp to 200C, hold 2hrs
  - Profile 2 (Air): 20min ramp to 130C, hold 30min + 15min ramp to 200C, hold 2hrs
- Die Shear:
  - HT DSS @ 260℃ set temperature

Workability
Open Time

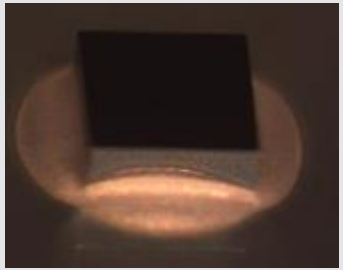
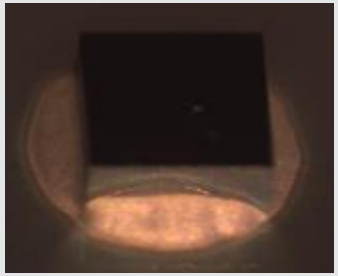
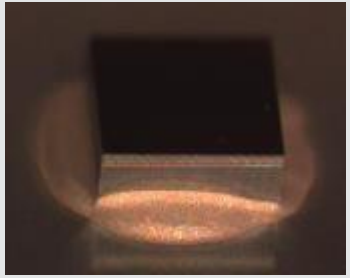
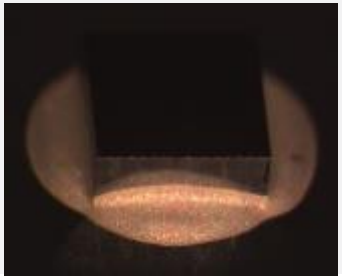
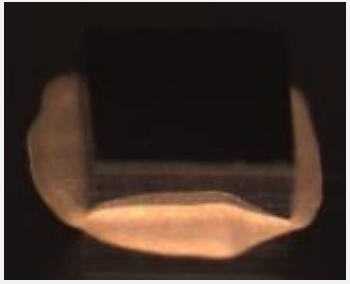
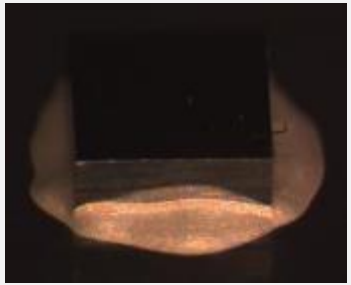
- Adhesives
  - Semi-sintering paste: ABP8068TB
  - Bath #:X09AUG17A
- QFN Lead-frame (7x7mm)
  - Ag & PPF
- Chip
  - Die Size: 1x1mm x 0.381
  - Back side Metallization: Ti-Ni-Ag
- EFD Needle ID
  - 0.2mm



QFN lead-frame

EFD needle

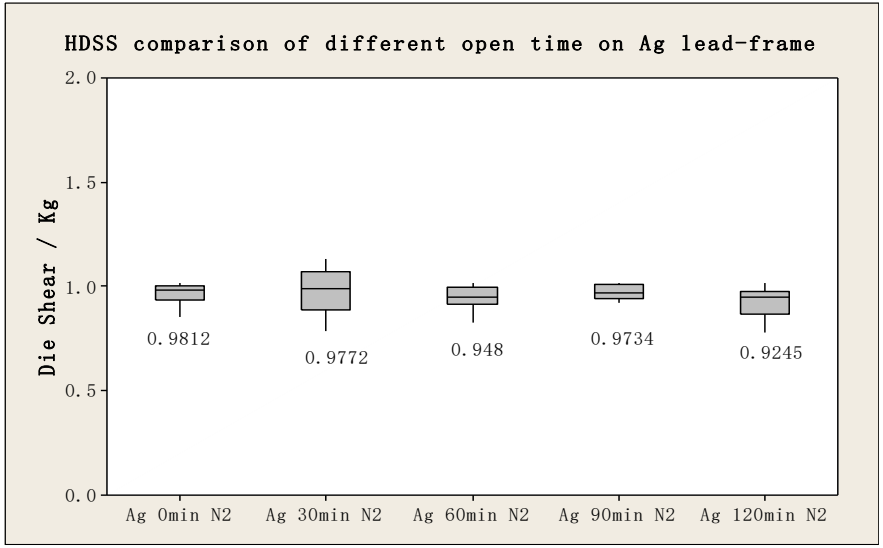
Workability
Open Time

	ABP806TB, T=0	ABP8068TB, T=60	ABP8068TB, T=120min
Ag			
PPF			

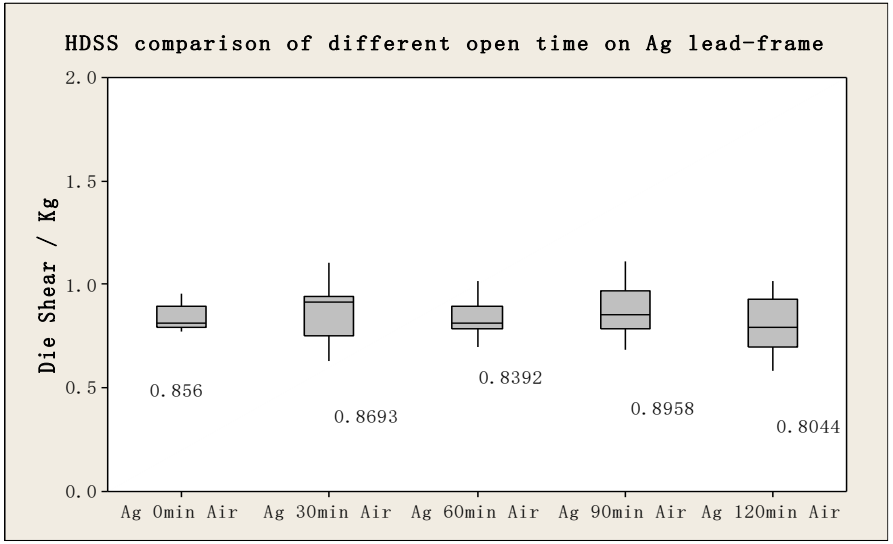
- ABP 8068TB can maintain stable fillet/coverage even up to 2 hours open time

Workability
Open Time

N2 cure



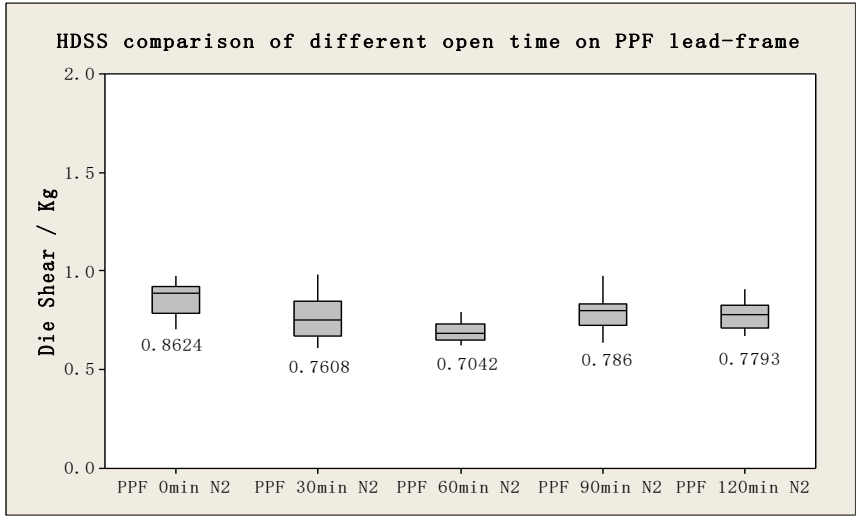
Air cure



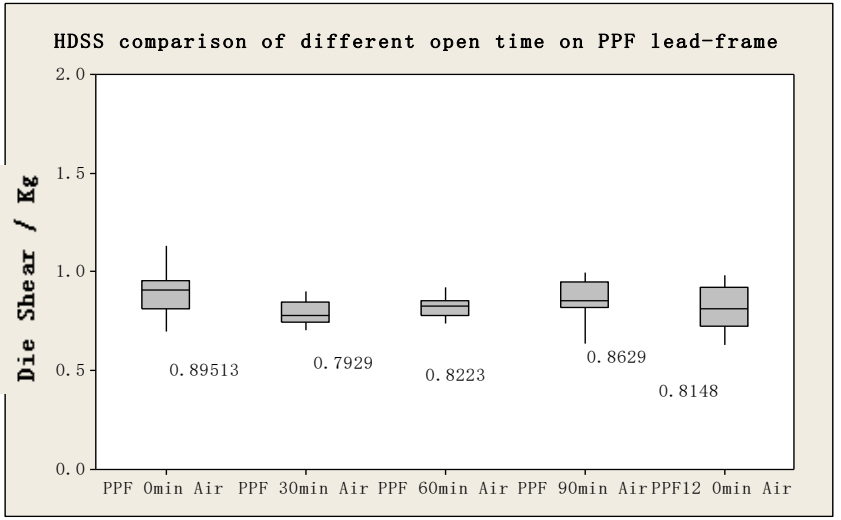
- ABP 8068TB can maintain stable HT DSS even after 2 hours open time on Ag LF

Workability
Open Time

N2 cure



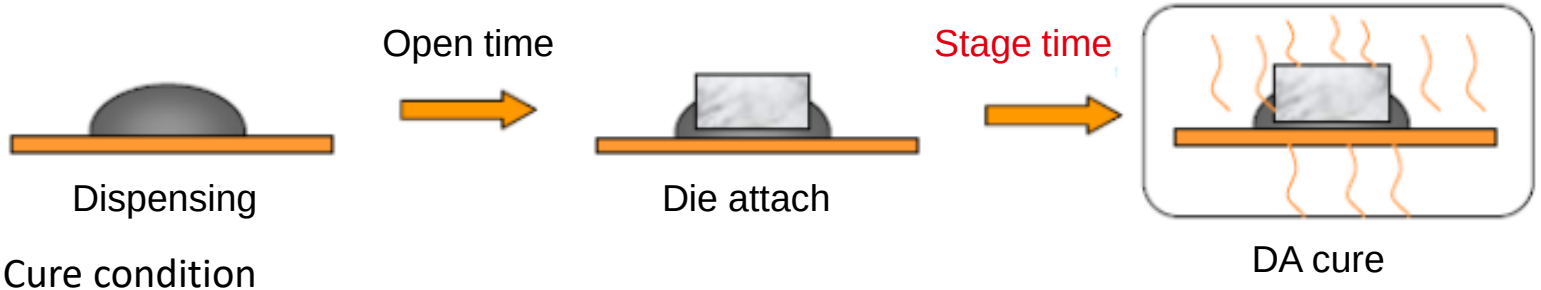
Air cure



- ABP 8068TB can maintain stable HT DSS even after 2 hours open time on PPFLF

Workability
Stage Time

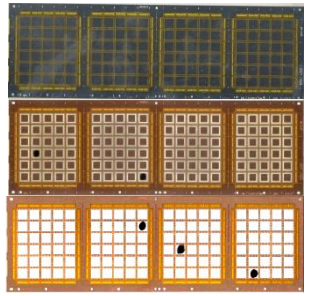
- Stage time: The time after die attach and before curing in oven.



- Cure condition
  - Profile 1 (N2): 20min ramp to 130C, hold 30min + 15min ramp to 200C, hold 2hrs
  - Profile 2 (Air): 20min ramp to 130C, hold 30min + 15min ramp to 200C, hold 2hrs
- Die Shear:
  - RTDSS: room temp. die shear
  - HTDSS: 260℃ hot temp. die shear
  - Pb HTDSS: 260℃ hot temp. die shear after Pb (121℃, 2atm, 100%RH 16 hours)

Workability
Stage Time

- Adhesives
  - Semi-sintering paste: ABP 8068TB
  - Bath #:X06DEC17A
- QFN Lead-frame (7x7mm)
  - PPF
- Chip
  - Die Size: 3x3mm x 0.381
  - Back side Metallization: Ti-Ni-Ag
- EFD Needle ID
  - 0.2mm

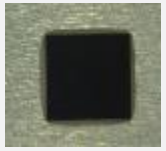
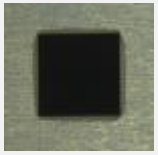
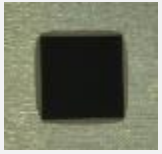
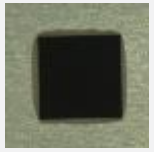


QFN lead-frame

EFD needle

Workability

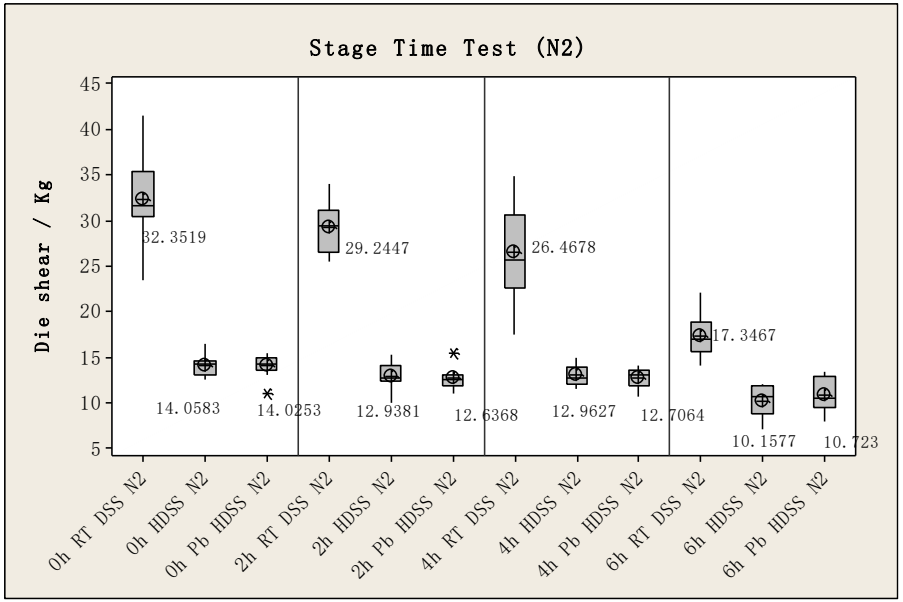
Stage Time

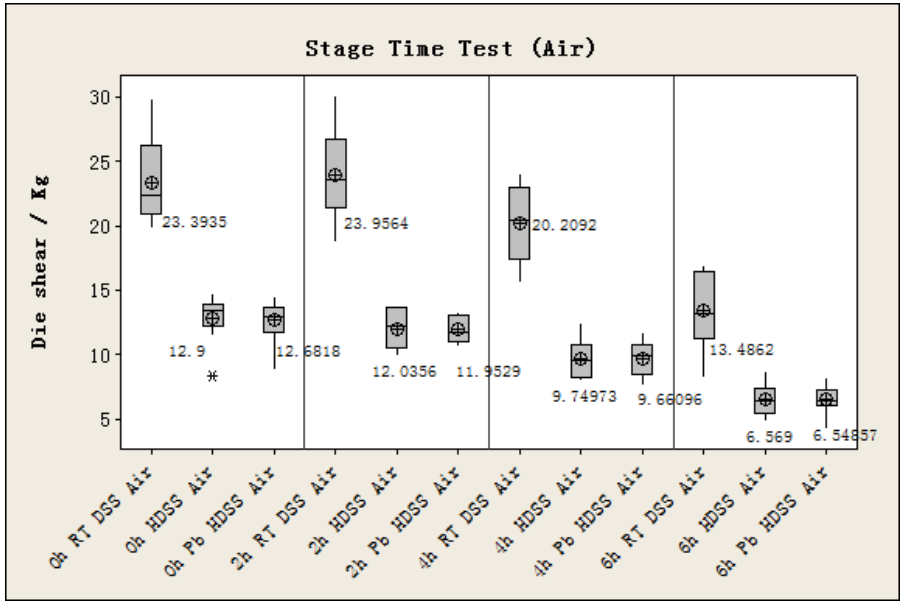
Test item	0h	2hr	4hr	6hr
	After cure	After cure	After cure	After cure
X-ray				
Coverage				
Fillet height				

BLT≈ 18um. Both air & N2 no voids detected

- ABP 8068TB shows zero voids even after 6 hours of staging in N2 curing

Workability
Stage Time





- ABP 8068TB show strong adhesion even after 4 hours in either N_2 or air cure condition
  - Noted a decline at 6 hours however still relatively have high adhesive value

Workability
Work Life

8068TB Worklife test data (@ 25℃)						
Time		Fresh	16H	24H	32H	48H
viscosity@5rpm (cP)		10850	13920	14830	16240	17480
viscosity increase		-	28.29%	36.68%	49.68%	61.10%
Volume resistance (Ohm.cm)		5.60E-06	5.50E-06	5.70E-06	5.50E-06	6.00E-06
260degC DSS (2X2mm Die),Kg	Sample #1	4	6.1	5.4	4.7	5.5
	Sample #2	5.3	6.2	6	5.2	5.4
	Sample #3	5.4	7.3	5.9	7.2	4.2
	Sample #4	6	7	6.4	6.9	6.9
	Sample #5	5.7	5.8	5.6	6.3	6.4
	Sample #6	5.9	5.7	6.3	6.4	6.6
	Sample #7	6.7	5.4	5.8	6.6	6.4
	Sample #8	5.9	5.7	5.4	6.4	5.3
	Average	5.61	6.15	5.85	6.21	5.84
Average dot size/mm		0.953	0.884	0.875	0.856	0.805

*Henkel work life reference: viscosity increase <=50%

*A corner batch with high increase of viscosity was selected for testing

- ABP 8068TB has 16 hours recommended work life*

Workability
Summary

ABP8068TB exhibited :

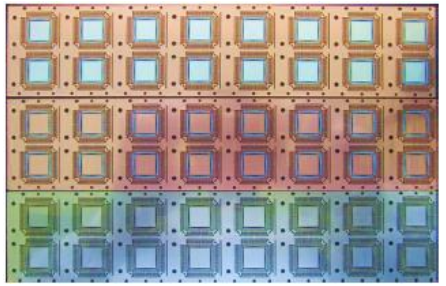
- Good resin bleeding control on different leadframe surface
- Stable and consistent dispensing. No missing dot or missing line was observed even up to 24hrs continuous dispensing
- Stable “open” time even up to 2 hours
- Stable “staging” time: recommend 4 hours
- Recommended work life of 16 hours

Void and Adhesion

Void & Adhesion

Test Vehicle

- Adhesives
  - Semi-sintering paste: ABP8068TB
  - Bath #:X05JAN18A
- QFP Lead-frame (10x10mm)
  - Cu, Ag, PPF
- Chip
  - Die Size: 1x1mm, 3X3mm, 5X5mm
  - Back side Metallization: Ti-Ni-Ag
  - Die thickness: 381um
- EFD Needle ID: 0.3mm

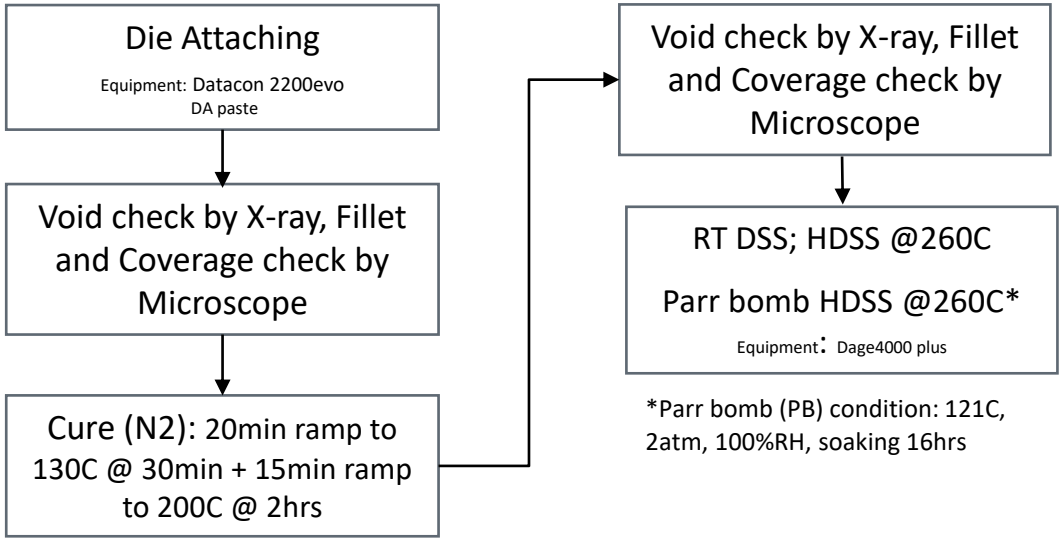


QFP lead-frame

EFD needle

Void & Adhesion

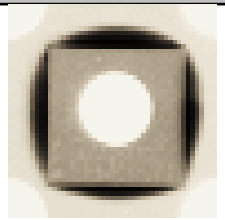
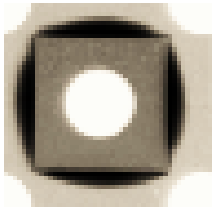
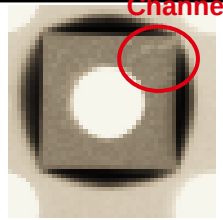
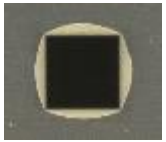
Test Flow



*Parr bomb (PB) condition: 121C, 2atm, 100%RH, soaking 16hrs

Void and Adhesion

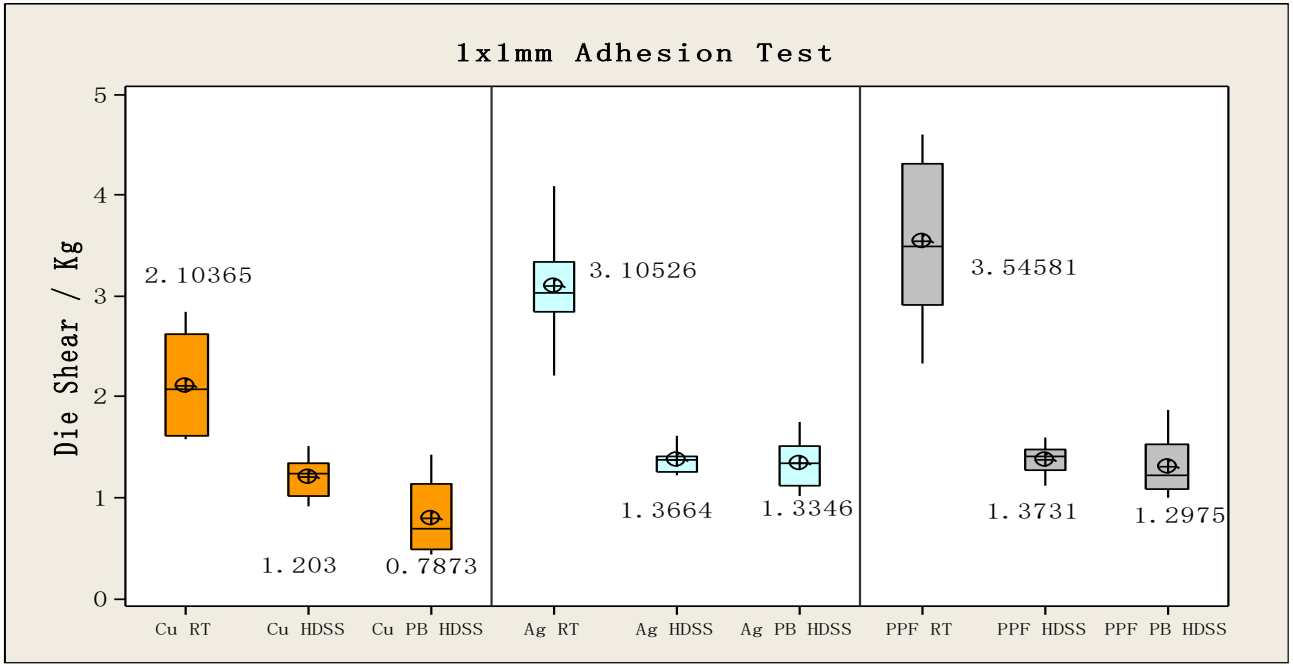
1x1mm Die

Test item	Cu	Ag	PPF
	After cure	After cure	After cure
X-ray			
Coverage			
Fillet height			

- On 1x1mm die, when wet BLT is **lower than 10um, channel void** was observed.
- Henkel recommends a wet BLT of >10um

Void & Adhesion

1x1mm Die

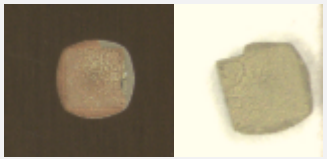
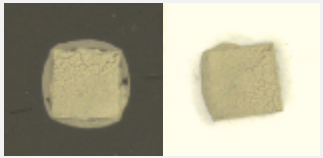
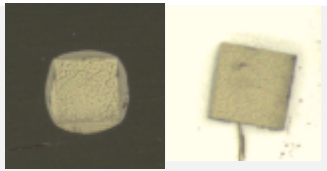
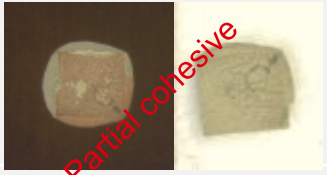
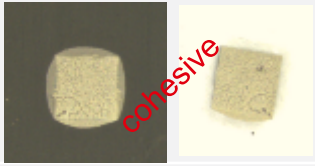
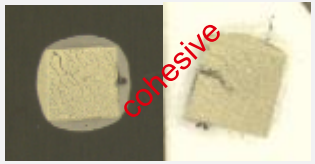
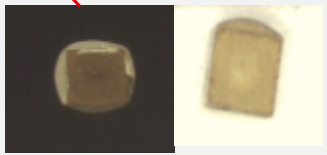
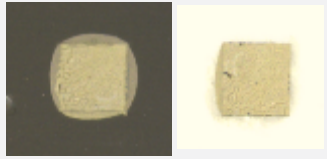
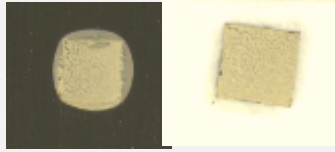


- ABP 8068TB has good adhesion performance on Cu, Ag & PPF lead-frame.

Void & Adhesion

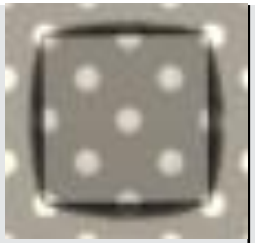
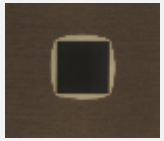
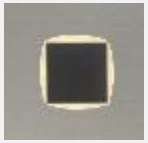
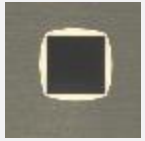
1x1mm Die

Failure Mode

Test item	Cu	Ag/Cu	PPF
	Failure mold	Failure mold	Failure mold
RTDSS			
260C HDSS			
260C Pb HDSS			

Void & Adhesion

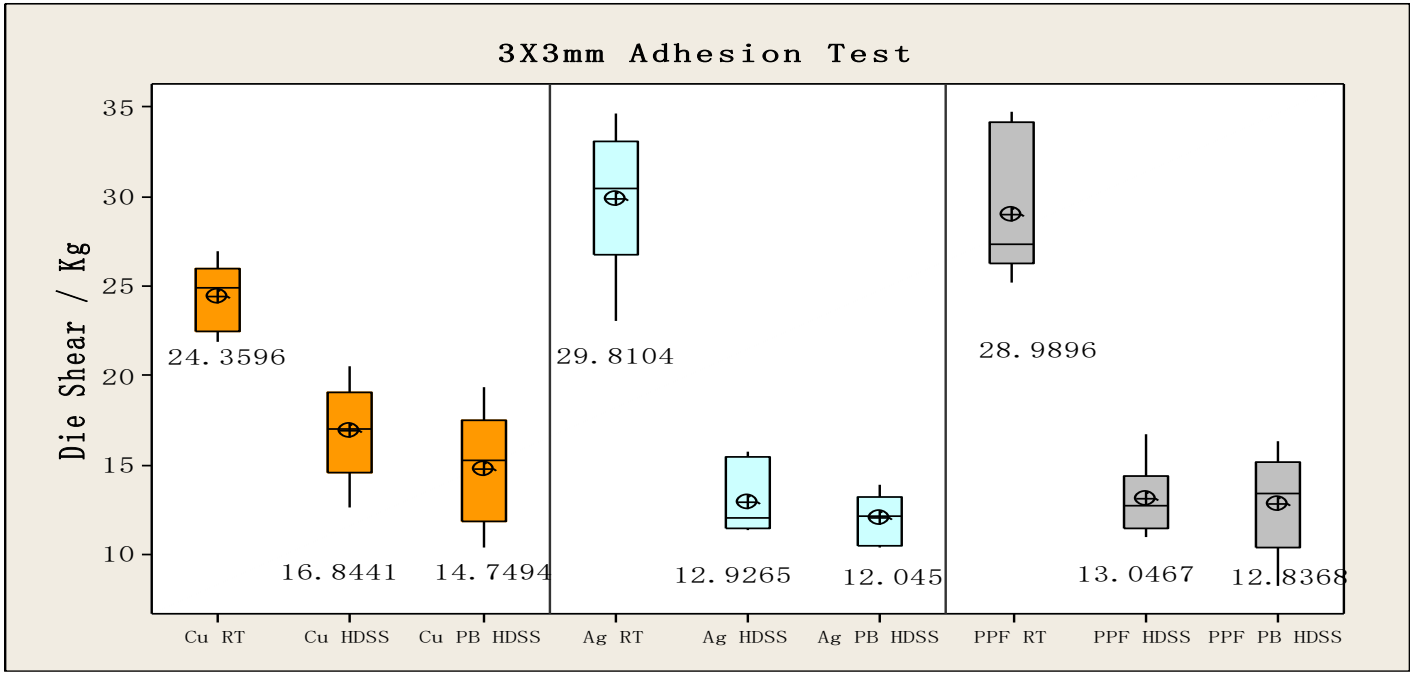
3x3mm Die

Test item	Cu	Ag/Cu	PPF
	After cure	After cure	After cure
X-ray			
Coverage			
Fillet height			

- ABP 8068TB shows zero voids on 3 x 3 mm die
- BLT controlled at 25um

Void & Adhesion

3x3mm Die

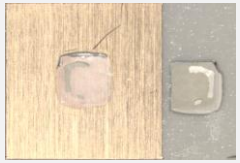
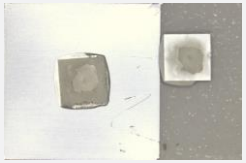
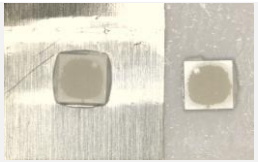
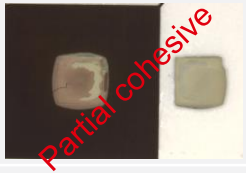
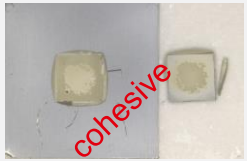
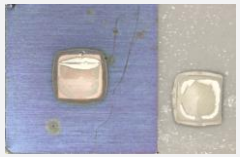
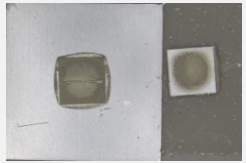
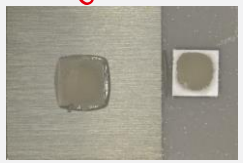


- ABP 8068TB has good adhesion performance on Cu, Ag & PPF lead-frame.

Void & Adhesion

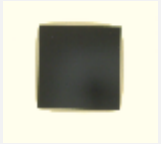
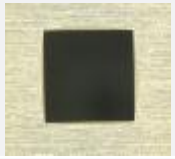
3x3mm Die

Failure Mode

Test item	Cu	Ag/Cu	PPF
	Failure mold	Failure mold	Failure mold
RTDSS			
260C HDSS			
260C Pb HDSS			

Void & Adhesion

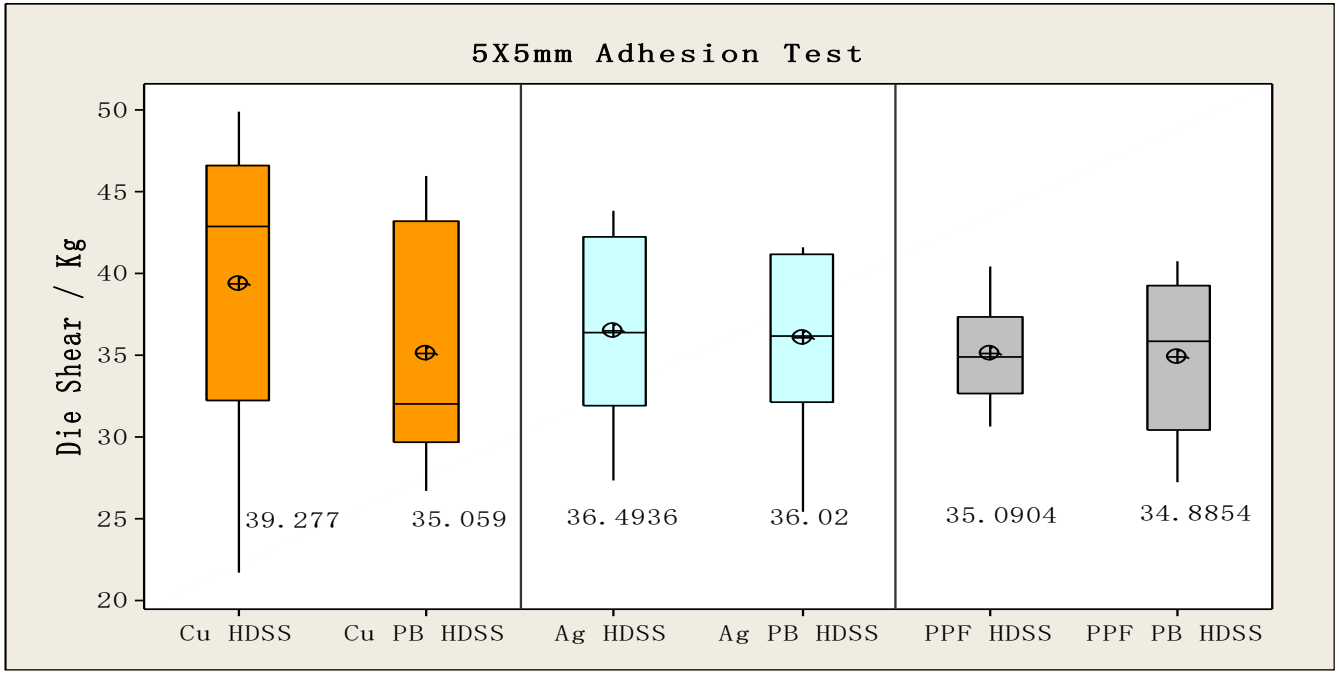
5x5mm Die

Test item	Cu	Ag/Cu	PPF
	After cure	After cure	After cure
X-ray			
Coverage			
Fillet height			

- ABP 8068TB shows zero voids on 5 x 5 mm die
- BLT controlled at 25um

Void & Adhesion

5x5mm Die



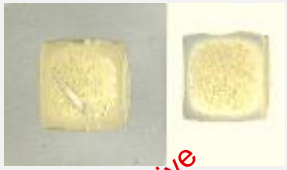
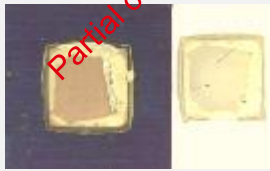
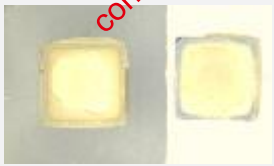
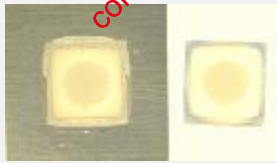
- ABP 8068TB has good adhesion performance on Cu, Ag & PPF lead-frame.

* RT DSS is too higher to test

Void & Adhesion

5x5mm Die

Failure Mode

Test item	Cu	Ag/Cu	PPF
	Failure mold	Failure mold	Failure mold
260C HDSS			
260C Pb HDSS			

Void & Adhesion

Summary

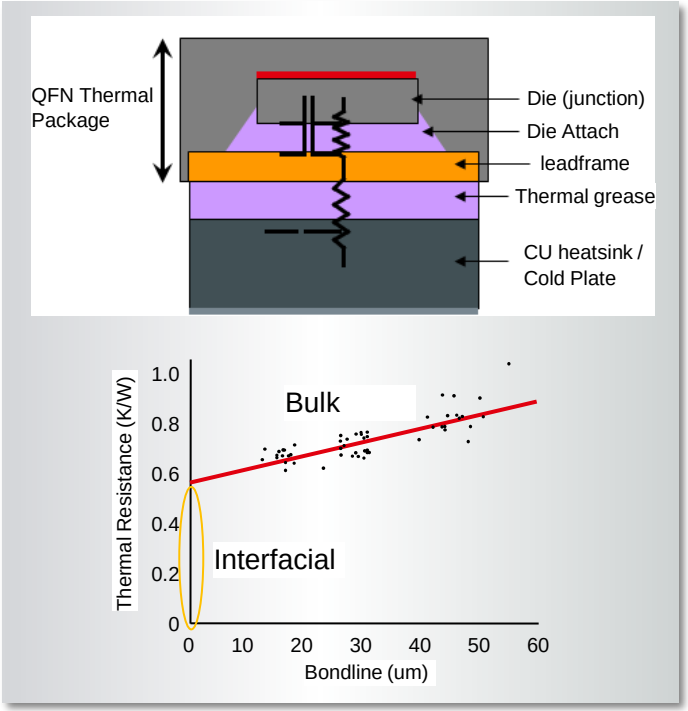
ABP8068TB exhibited:

- Void free bond line when BLT is controlled at 25um. Zero voids observed on big die size upto 5x5 mm
- Excellent adhesion on PPF and Ag LF. Adhesion on Cu LF is slightly lower however still exhibited good level of adhesion. Noted cohesive failure mode on Ag and PPF while partial cohesive failure mode on Cu LF.

In Package Thermal Resistance

In Package Thermal Resistance
Introduction

- Thermal Conductivity [W/mK] is an intrinsic material property
- Thermal Resistance, R_{th} [K/W], is a geometry dependent value that allows us to better compare materials in a functional package
  - 70 – 90% of the R_{th} is due to the interfaces and is not captured in thermal conductivity values

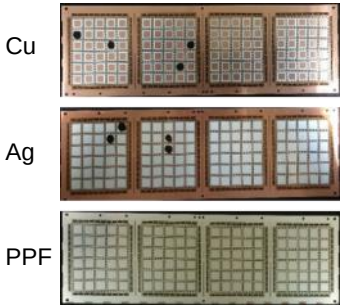


Interfacial Conductivity, Rather than Bulk Properties Has the Highest Impact on Thermal Performance

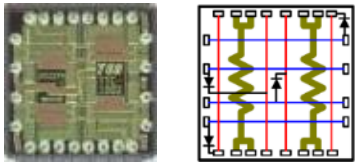
In package Thermal Resistance

Test Vehicle

- Die: thermal resistance test function die, 2.54mmx2.54mm, 15mil thickness, Au backside
- Package: QFN 7X7, Ag & PPF lead frame
- 1 mil gold wire
- Molding compound: Sumitomo EME-G770HCD



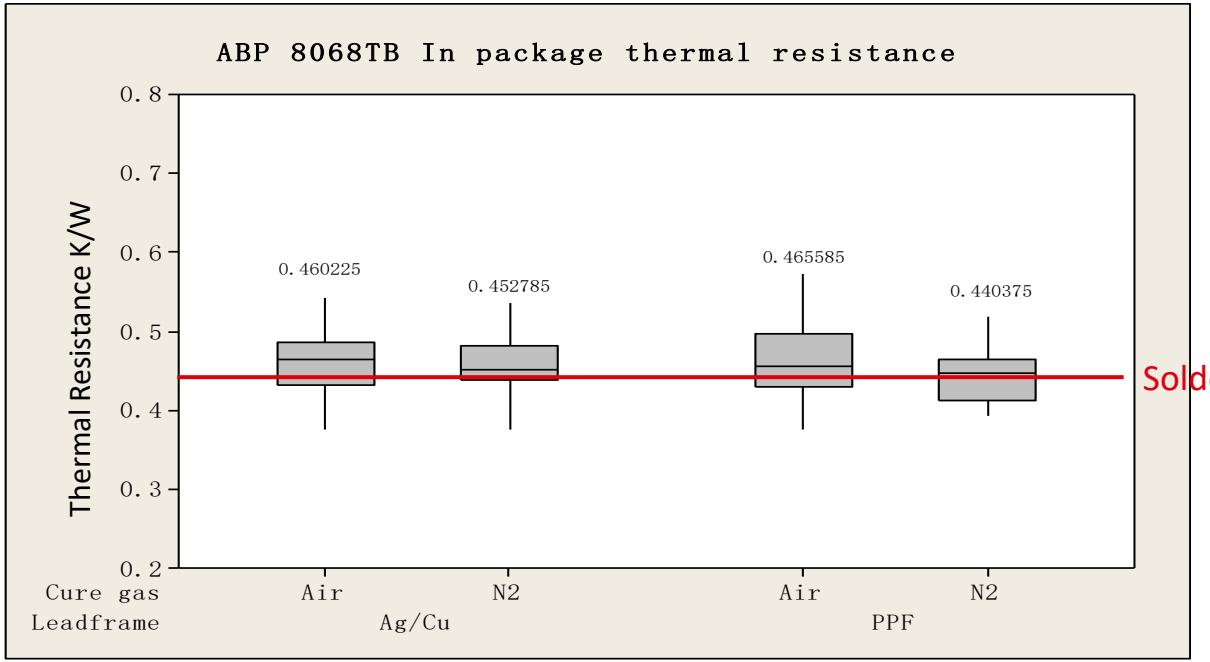
QFN 7X7 LF



Functional die

Electrical – Heating : TTC-1002 # of Resistors : 2
Resistance Value : 7.6 Ω ±10 % (each resistor)
Resistance Variation : ±5 % (for die from a specific wafer)
Max Resistor Power : 6 W (6V @ 1A) each

In Package Thermal Resistance
Result



- Excellent in package thermal performance, comparable to solder

Semi (Hybrid) Sintering Paste

ABP 8068TB External Reliability Data

Package Type	Die Size (mm)	Die Thickness	Die BSM	L/F Finish	MSL1	MSL2A	MSL 3	TCT	HTS 1000hrs (150C)	uHAST (130C/85%)
QFN	2.4X1.6	160um	TiNiAg	Cu	PASS					
LGA	0.5X0.5~1X1	100~200	Au	Au			PASS	PASS 500 (-55C/+125C)		PASS
SiP	1.2x0.9	75um (GaAs)	Au	Au		PASS	PASS	PASS 1000 (-55C/+125C)	PASS	PASS (96hrs)
SiP	1.2x0.9	75um (GaAs)	Au	Au			PASS	PASS (-55C/+125C)	PASS	PASS (96hrs)
SiP	1.3x0.6	75um (GaAs)	Au	Au		PASS	PASS	PASS (-55C/+125C)	PASS	PASS (96hrs)
SiP	1.3x0.6	75um (GaAs)	Au	Au			PASS	PASS (-55C/+125C)	PASS	PASS (96hrs)
SiP	2.0x1.0	(GaAs)	Au	Au			PASS			
SiP	2.0x2.0		Ag	Au			PASS			
LGA	4.0x3.0	200um	Au	Ag			PASS			

ABP8068TB Summary

- Henkel has supplemented its portfolio of die attach paste solutions with a novel semi-sintering, ultra-high thermal, conductive die attach portfolio.
- These solutions can be applied using processes similar to those employed with standard die attach pastes – no need of high temperature and pressure for sintering
- This technology delivers a robust, lead-free solder alternative solution with best-in-class electrical and thermal performance. These materials have lower in-package thermal resistance than many standard die attach pastes on silver, copper and PPF lead frames
- LOCTITE ABLESTIK ABP 8068TB is the next product in the family, with focus on reducing resin bleed on roughened and ceramic substrates.

Thank you!

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