Ormet TLPS Introduction

Portfolio and application roadmap

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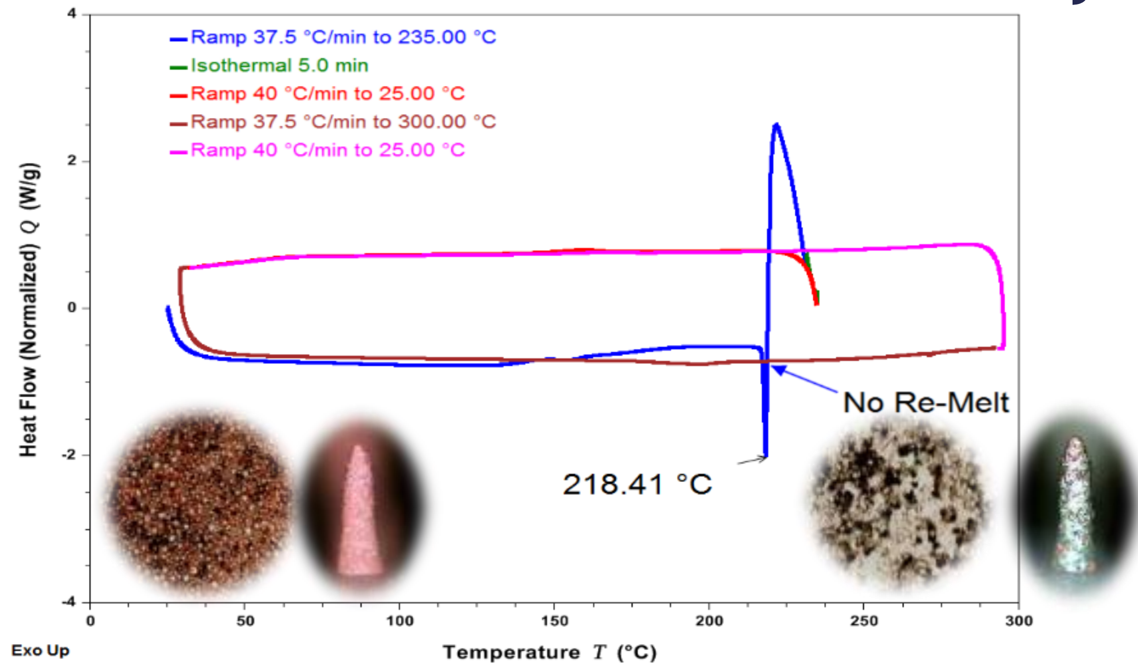
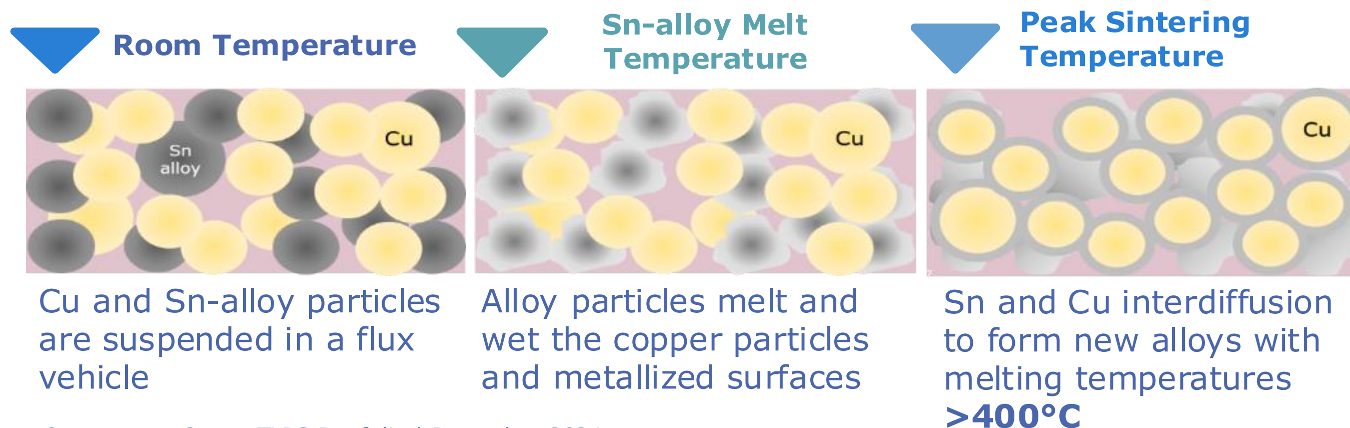
What we make:
Transient Liquid Phase Sintering: Ormet® TLPS



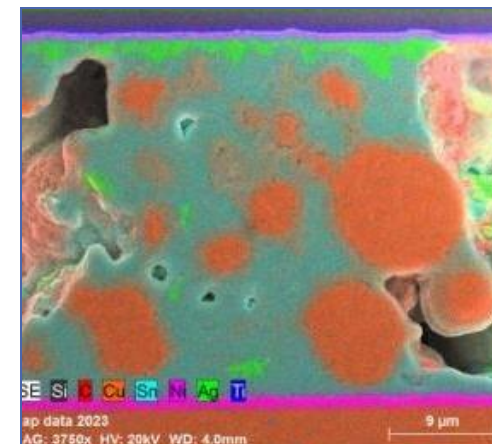
- **Processes like solder**
- **Electrical, thermal and mechanical characteristics like solder**
- **Does *not* remelt like solder – multiple assembly steps can be accomplished with the same paste formulation**



Cu and Sn-alloy particles are suspended in a flux vehicle

Alloy particles melt and wet the copper particles and metallized surfaces

Sn and Cu interdiffusion to form new alloys with melting temperatures **>400°C**



Packaging interconnect solutions

Key benefits of TLPS (Transient Liquid Phase Sintering)pastes

Ormet® TLPS sintering paste provides **enabling** materials **technology**

1 Low temperature **metallic joining**

Processing in standard **Pb-free reflow** profile

2 **Thermally stable** metallurgy after reflow

Improved fatigue resistance relative to solder

3 Superior strength retention at **elevated temperatures**

No re-melt below 400°C – high operating temp capability

4 **Pb-free** & **Halogen-free** **c**omposition

Copper and tin-based alloys

5 **Excellent e**lectrical and thermal **conductivity**

<100 μΩ/cm **electrical**

25-60 W/mK **thermal**

Competitive landscape

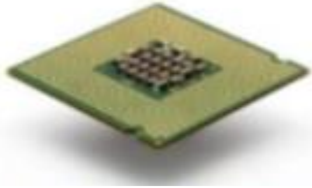
	Feature	Conductive Adhesives	Solder Paste	Ormet® TLPS-Paste	Ag-sintering
General Property	Process Temperature	120-175℃	190-350℃	**190-260℃**	200-280℃
	Bonding Mechanism	Adhesive(Chemical bond)	Metallurgical	**Metallurgical**	Metallurgical
	Reaction Process	Box oven	In-line reflow	**In-line reflow / Box oven**	**Thermal compression**
	Sintering pressure	0MPa	0MPa	**0MPa**	**10~30MPa**
	Thermal conductivity (W/m.K)	**<10**	20-60	**20-60**	>100
	Electric Resistivity (μΩ.cm)	**<100**	10-30	**10-50**	<10
	Flux Residue	No	**Yes**	**No**	No
	Will Re-Melt in 2nd Reflow?	**No (Tg)**	**Yes**	**No**	No
Application	Power die attach	✓	✓	✓	✓
	Component manufacture		✓	✓	
	Component attach		✓	✓	
	BGA attach		✓	✓	
	PCB Z-axis interconnects	✓		✓	

TLPS pastes are a versatile technology platform

Strong value proposition in HDI PCB, complex assemblies and harsh environment

Advanced Packaging Assembly(SiP)

- Replace lead-free solder



- Multiple assembly cycles with no remelt
- Superior fatigue resistance

Power/harsh environment Assemblies

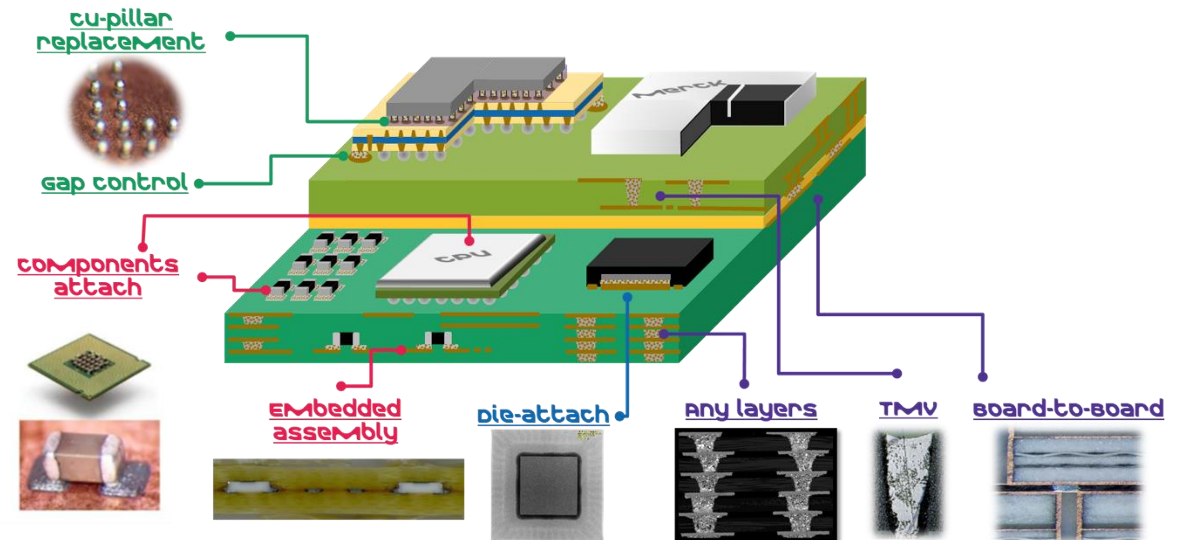
- Replace Ag-sinter, solder, TIM

- High thermal durability
- Multiple assembly cycles with no remelt

5G (Antenna/Sever) Z-axis interconnects

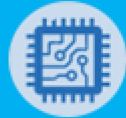
- Replace/augment copper-plating

- Paste + novel process
- Enable complex PCB in high yield



Market overview
Focus areas for TLPS paste

HDI PCB fabrication



Where?

5G mm Wave infrastructure

Substrate with embedded power management

Military telecom and radar infrastructure

CPU test and server motherboard

Why?

Higher density, tighter pitch

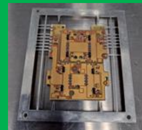
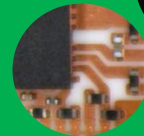
Higher yield

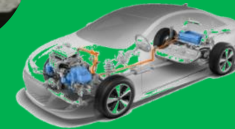
Faster throughput – lower energy, waste

Better RF performance

Improved design flexibility

SiP and Power Module



Where?

Fine pitch assembly for semi packaging and modules

Passive component embedding in PCBs

Power assembly solutions for EV, solar, IoT and sensor applications

Why?

No remelt in complex module assemblies

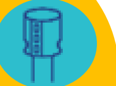
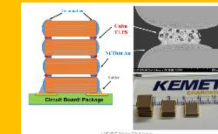
Small component/pitch capability

Superior fatigue resistance

Die/component/lead frame assembly with a single material and reflow

High operating temperature capability

Component fabrication

Where?

Stacked capacitors for power management

- Leaded
- Leadless

PCB-mounted fuses

Why?

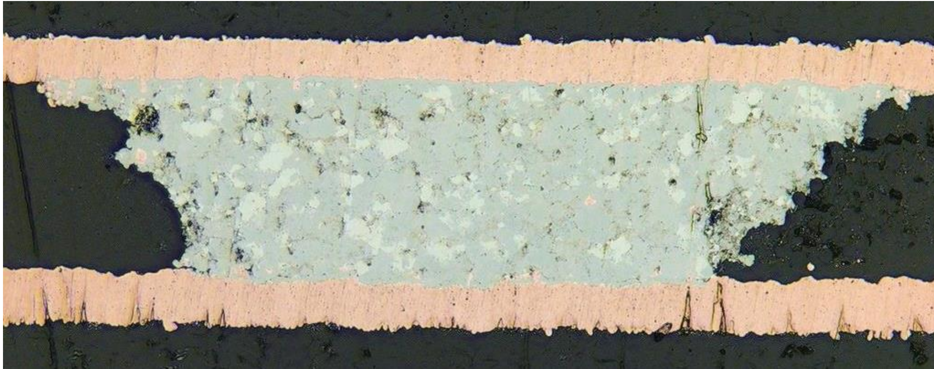
Unique architecture = higher power density and superior thermal dissipation

No remelt

High operating temperature capability

TLPS for Z-axis interconnect

High layer count PCBs Z-axis interconnects
Uses, drivers, and advantages



Design Flexibility for higher density

- Ormet pastes eliminate complex drilling and plating processes,

Production yield improvement by process steps reduction

- leading to improved yield compared to conventional build-up plating processing

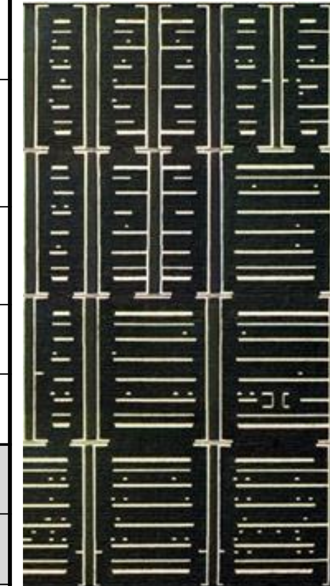
Higher Aspect-ratio through holes

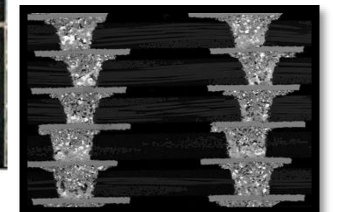
- Manufacture subassembly ‘cores’
- Interconnect using paste via layers
- Proven reliability and good yield
- Simplified process leads to lower cost

Better performance, shorter cycle time and higher yield than conventional technology for complex substrates

PCB Z-axis interconnect product line
Robust interconnect with high design flexibility

Typical Properties			PCB-701	PCB-710	PCB-805
Product Design for			Via Filling Paste	Via Filling Paste	Thermal drain (PTH only)
Pre Sintered	Filler type		Cu and Sn-alloy	Cu and Sn-alloy	Cu & Sn-alloy
	Nominal Particle Size	um	<20	<20	<20
	Viscosity @ 5rpm	kcps	135 Brookfield TE Spindle	380 Brookfield TE spindle	450 Brookfield TE Spindle
	Thixotropic Index	slope 1:10rpm	1.4	3.5	5
	Work Life @ 25℃	Hours	>4	>4	8
	Storage Life <-10℃	Months	12	12	12
Post Sintered	Metal Loading	Wt %	92	98	96
	Volume Resistivity	uΩ.cm	50	35	30
	CTE	ppm/℃	22	19	19
	Thermal Conductivity	W/m.K			50





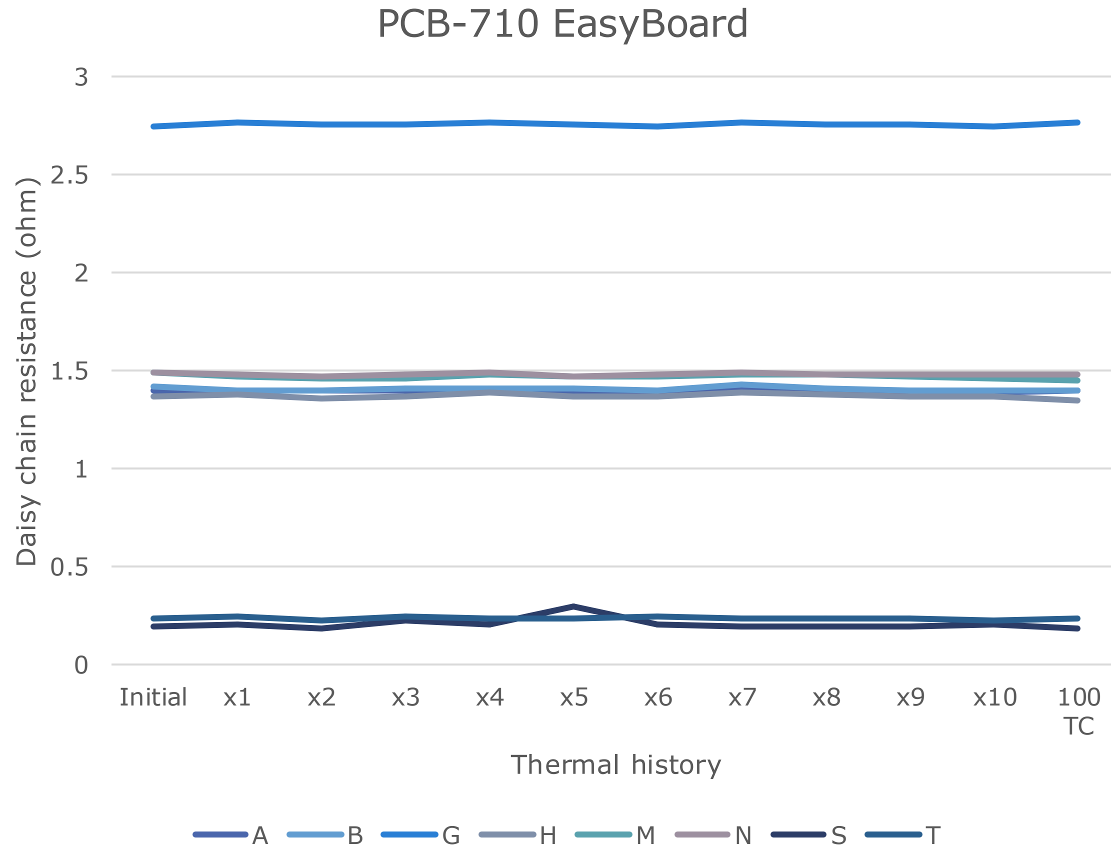
Ormet PCB-710

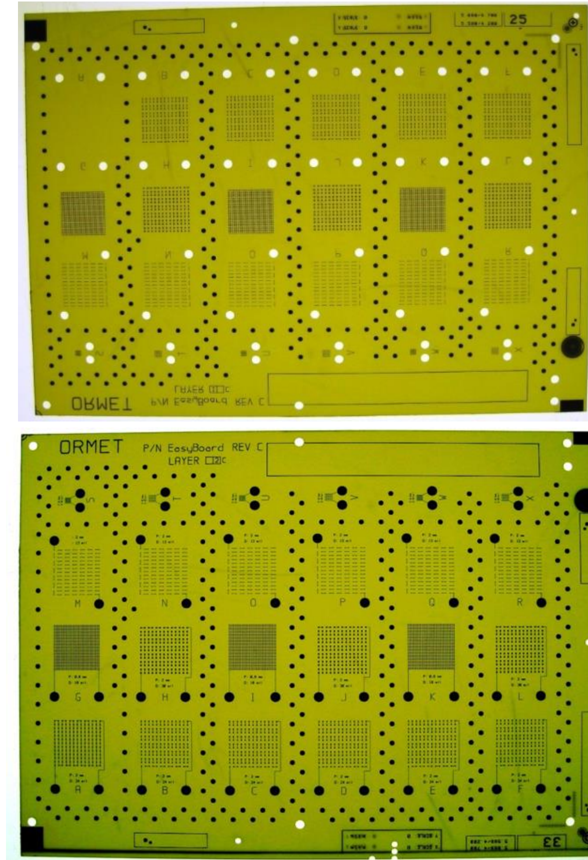
Resistance stability: reflow and thermal shock

Electrical results:

- As laminated
- After each 260C peak SAC-type reflow (tunnel furnace)
- After 100 -65C -> 150C air-to-air thermal shocks
- Resistance increases at peak temperature, but does not go open

High Reliability!





Circuit index (pitch and pad size vary per circuit):

A, B – 250µm, 169 vias

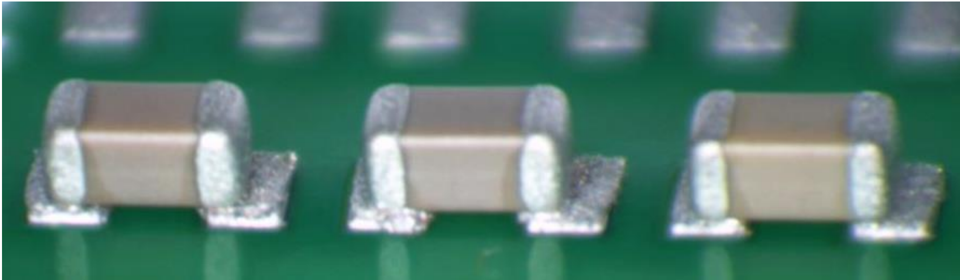
M, N - 150µm, 169 vias

G, H - 200µm, 900/169 vias

S, T - 100µm, 64 vias

Component Assembly

Solder replacement for complex assemblies and harsh conditions
Solving re-melt, fine pitch placement and fatigue resistance issues



Processable like Pb-free solder

- Lead-free reflow with inert environment
- Dispense or stencil print
- Compatible with all solderable finishes

Will not remelt below 400°C after reflow

- Step soldering (all lead-free)
- High operating temperature (>250°C, lead-free)

Shape maintained though processing

- Enabling higher density assembly

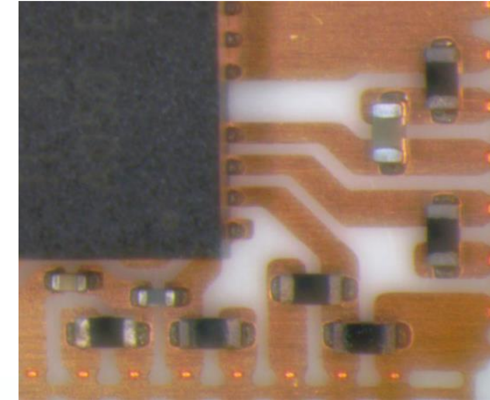
Reduced risk of shorting

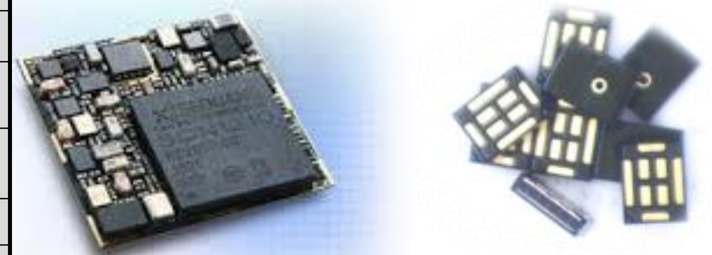
- No tombstoning
- Comparable electrical, thermal and mechanical properties to solder

Higher fatigue resistance than solders in temp cycle

Component assembly/attach product line
Uses, drivers, and advantages

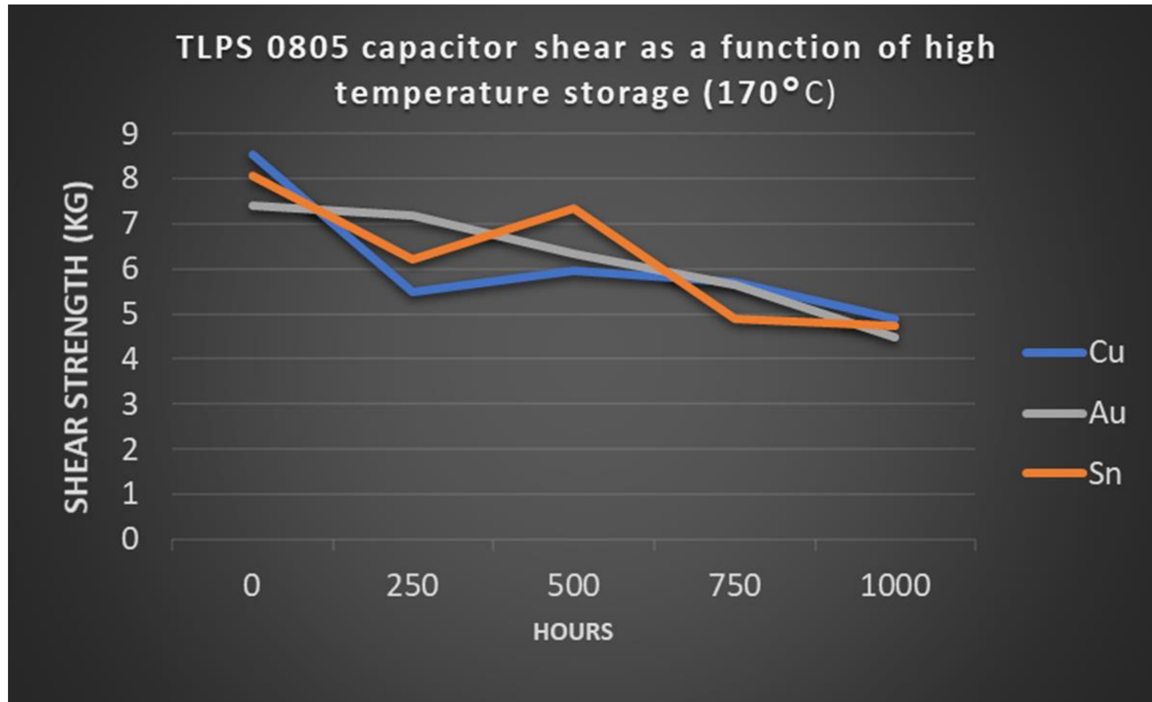
Product		CAP-476-1	CAP-823-1	CAP-824-3	APM-916-1
Target application		Component assembly	Fine pitch component assembly	High thermal durability assembly	Dispensable component assembly
Fillar system		Sintering (Cu, Sn-alloy)	Sintering (Cu, Sn-alloy)	Sintering (Cu, Sn-alloy)	Sintering (Cu, Sn-alloy)
Viscosity	CP51 2.5rpm, kcps	55	210	190	50
Nominal particle size	um	<20um	<33um	<20um	<40um
Method of application	Stencil Printing	○	○	○	
	Dispensing	○			○
Volume Resistivity	(μΩ.cm)	20	18	18	18
Shear Strength	(kg/mm2)@25℃	4	4.2	4	3.6
	(kg/mm2)@260℃	2.5	2.5	2.5	2.5
	(kg/mm2)@325℃	NA	NA	NA	NA
Applicable interface material	Au	○	○	○	○
	Ag	○	○	○	○
	Cu	○	○	○	○
	Ni	○	○		○
	Sn	○	○	○	○

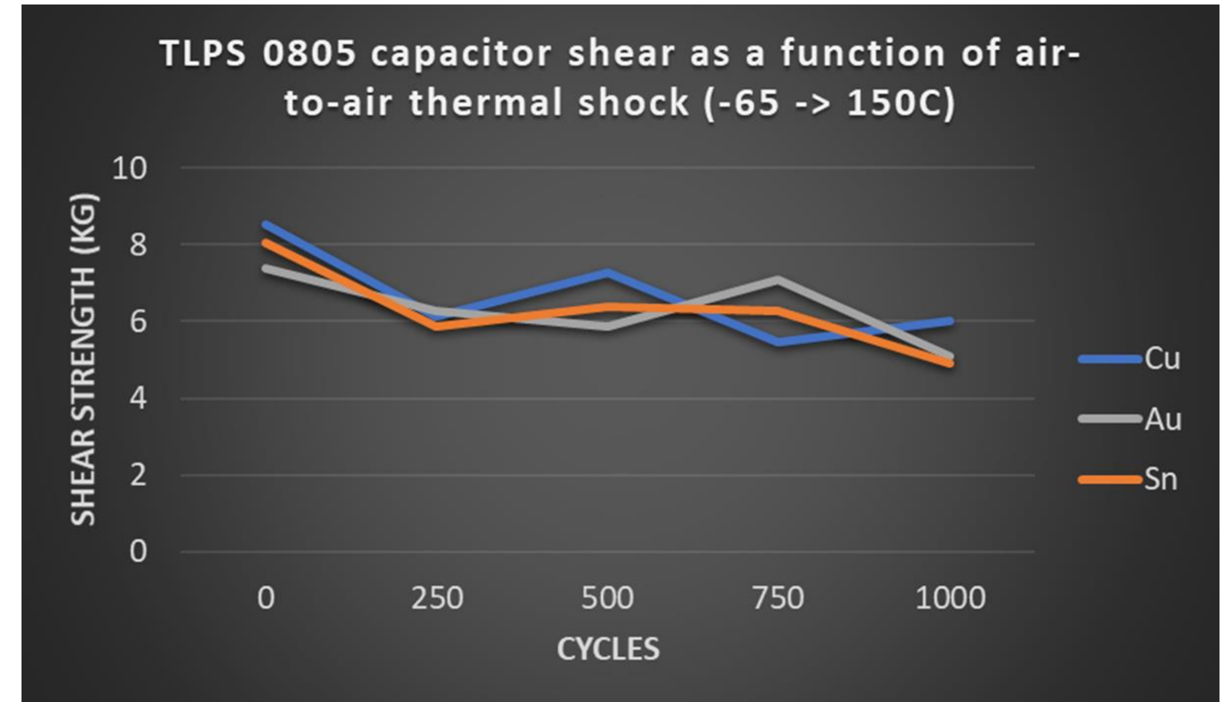




Performance and Reliability

CAP TLPS paste surface finish compatibility





All solderable surface finishes are compatible!

Power Die Attach

Die attach for power modules
Product performance (DAP-481-1 , DAP-491-1)

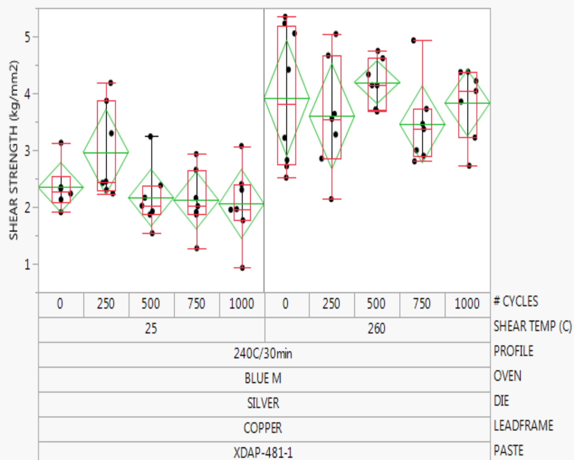
	DAP 481-1	DAP 491-1
Target Application	• Die-attach on DBC (<10×10mm) : IGBT module • Die-attach on LF (250umt) (<8×8mm) : Discrete (not including clip structure)	
Overall Product Features	• Wide process windows • Printable & Dispensable • Available for Reflow and Oven profile	• High thermal conductivity • Printable • Available for Reflow and Oven profile
Metal Loading (wt%)	90	93
Thermal Conductivity (W/m-K)	31	52
Viscosity (5.0 RPM CP-51, cps)	21000	68000
Thixotropic Index (0.5/5.0)	3.6	2
Slump test (minimum µm gap no bridge)	200	150
Stencil Life (hrs)	8	>8
Die Attach Window (hrs)	6 (die on LF)	2 (die on LF)
3x3 Au die on Cu LF X-ray void%	10%	10%
3x3 Au die on Cu LF RT shear (kg/mm^2)	3.0	5.2
3x3 Au die on Cu LF 260C shear (kg/mm^2)	4.2	5.7

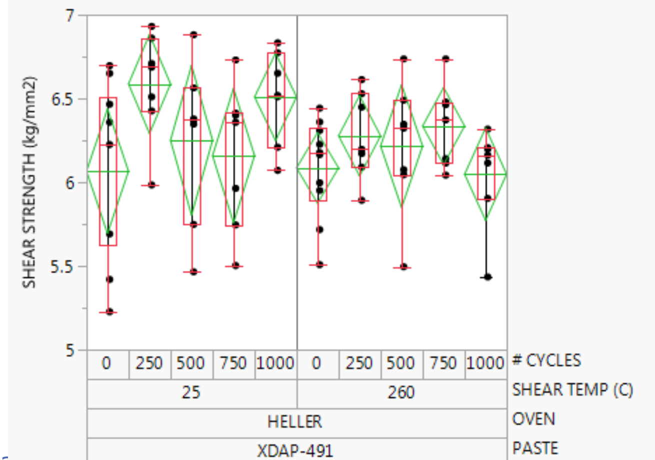
TLPS paste designs for die attach
'Thermosetting' solder paste

- **Features and Advantages**

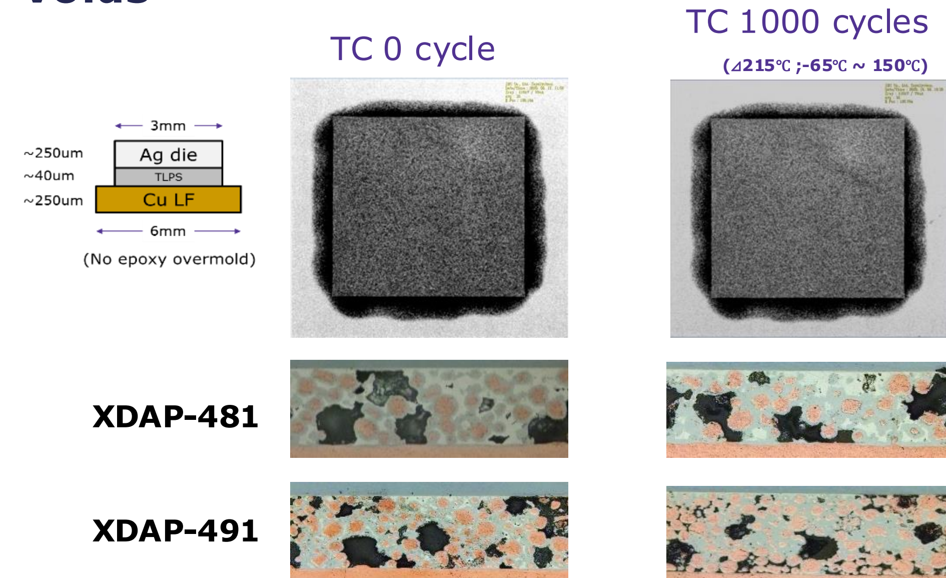
1. **Pb-Free Systems**
2. **Non-loading pressure**
3. **Stable thermal conductivity (50W/m.K)**
4. **Wide process window, print or dispense; reflow or oven sinter**
5. **Excellent metal bond strength to solderable/metalized die before/after thermal cycles**
6. **No-Remelting under 400℃**

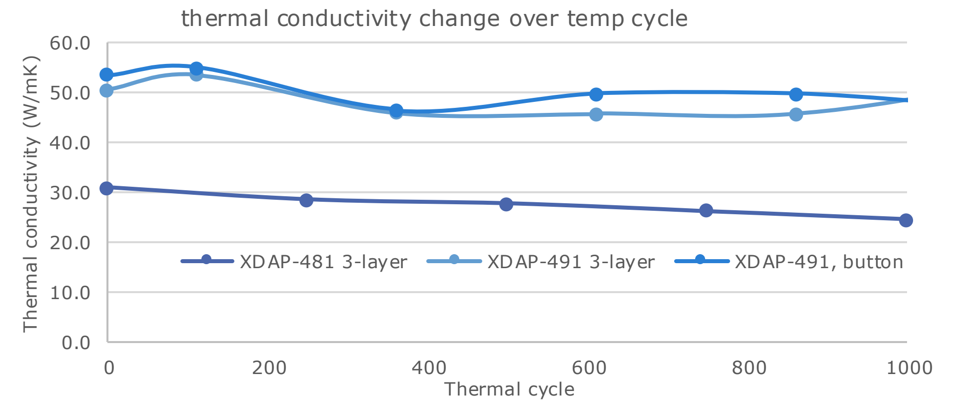
- **Stable Shear Strength (RT and over 260℃)**





Stable microstructure with small dispersed voids





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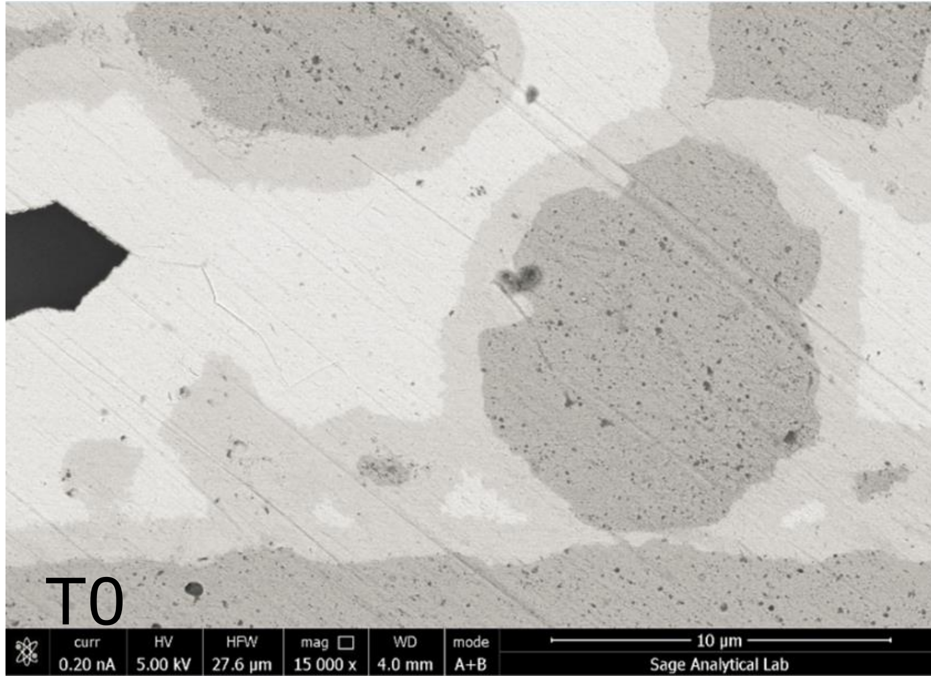
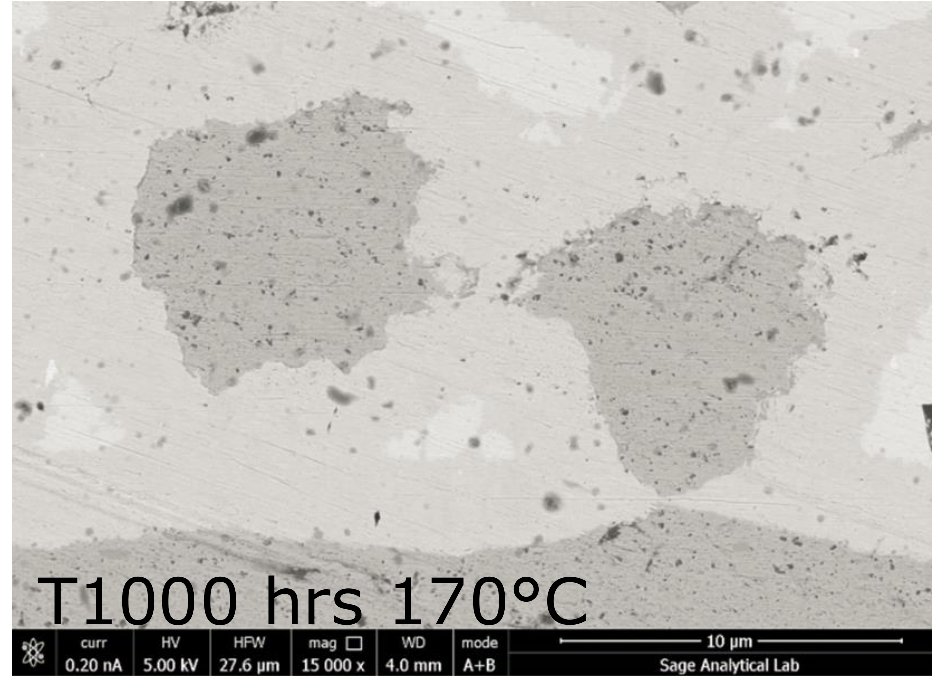
TLPS is highly stable

IMC conversion occurs at the interface and through the bulk





Thermal work does not degrade joint performance

	Post Oven Cure	100hrs @170°C	250hrs @170°C	500hrs @170°C	1000hrs @170°C
AVG. IMC (um)	1.475	2.043	2.119	2.733	3.384
Strength (kg/mm^2)	1.2	1.303	1.328	1.429	1.434