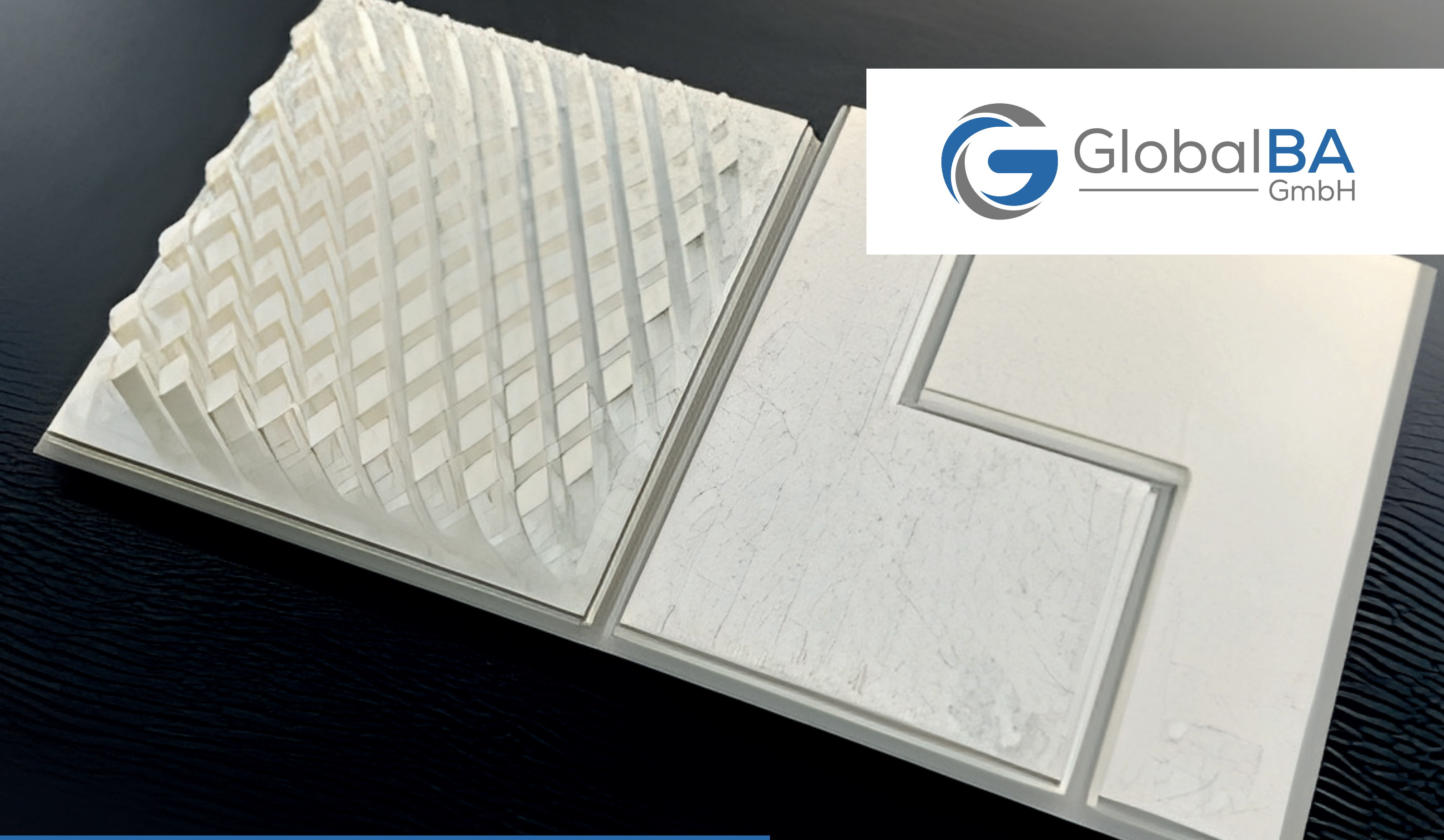
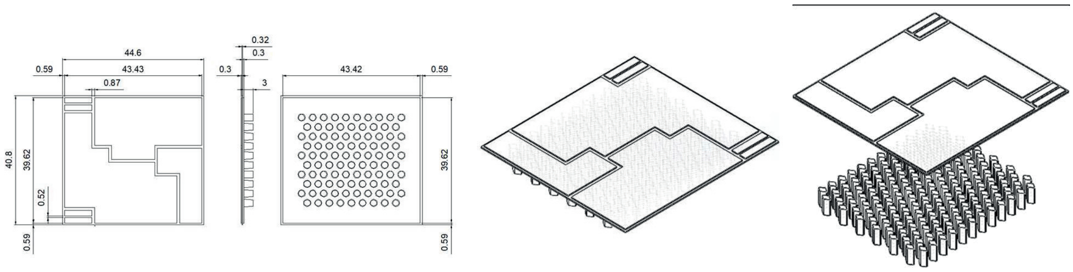


PIN DIRECTLY BONDED AMB

INTEGRATED HEAT SINK ON AMB SUBSTRATE

Integrated Heat Sink on AMB Substrate (Pin directly bonded AMB)

Div.	Pin Directly Bonded AMB
Drawing	
Dimension	-. AMB Substrate with PIN : 44.6mm x 40.8mm x 3.92mm -. AMB Combination : 0.3t Cu / 0.32t Si3N4 or 1.0t AlN / 0.3t Cu -. AMB Dimension : 44.6mm x 40.8mm x 0.92mm -. PIN : 98-Ø2.3 x 3mm
Remark	-. Heat Spread, Miniaturization, Weight Reduction, etc. -. Complex Bonding Solution (250W/m·K)

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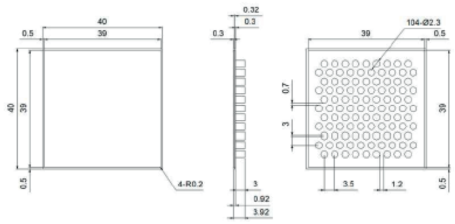
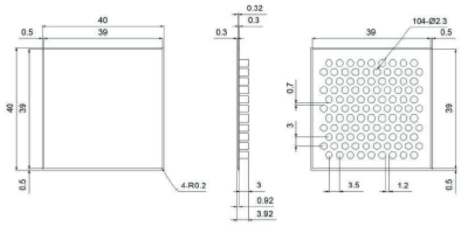
04/2026

FEASIBILITY TEST OF PIN DIRECTLY BONDED AMB

● Design Outline

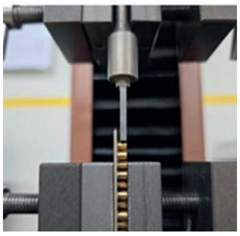
Div.	Sintering Type	Brazing Type
Figure		
Dimension	AMB: 40mm x 40mm x 0.92mm & PIN: 104-Ø.3 x 3.0mm Combination -.0.4t Cu / 0.32t Si_3N_4 / 0.4t Cu / 3.0t Cu, 40mm x 40mm x 3.92mm	AMB: 40mm x 40mm x 0.92mm & PIN:104-Ø2.3 x 3.0mm Combination -.0.4t Cu / 0.32t Si_3N_4 / 0.4t Cu / 3.0t Cu, 40mm x 40mm x 3.92mm
Pin Bonding	Bonding Materials: Ag Sintering Paste Bonding Condition -.Temp. : 280°C ± 20°C, Pressure: >250MPa	Bonding Materials: AgCu Alloy Bonding Condition -.Temp.: > 780°C, Atmosphere of Reduction: H2-N2 Mixture Gas
Evaluation	-.Shear Strength, Warpage -.TST(SAT Analysis): 0,500, 1000cycles	-.Shear Strength, Warpage -.TST(SAT Analysis): 0,500, 1000cycles

Feasibility test done with Si_3N_4 substrate for the comparison between sintering and brazing bonding

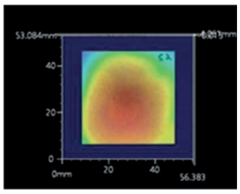
FEASIBILITY TEST OF PIN DIRECTLY BONDED AMB

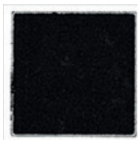
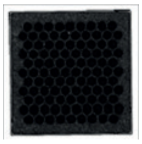
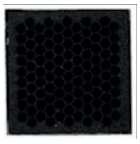
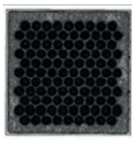
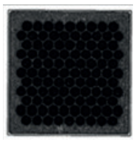
● Test Results

● **Shear Strenght Test**



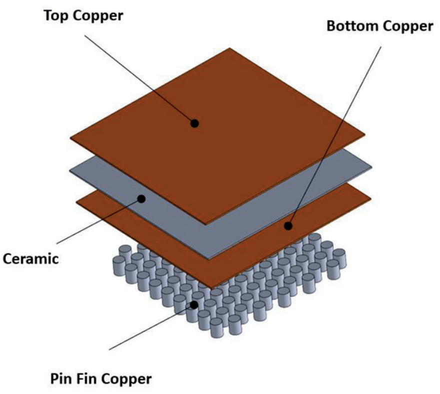
● **Warpage Test**



Div.	Sintering Type			Brazing Type		
	As received	500 cycles	1000 cycles	As received	500 cycles	1000 cycles
Shear Strength (MPa)	66.35	35.99	32.30	151.51	85.09	60.33
Warpage (mm)	0.178	0.125	0.084	0.267	0.077	0.116
SAT (C-SAM)	OK	OK	OK	OK	OK	OK
						
						

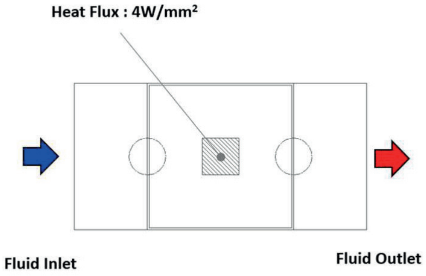
1. AMB LAYER MATERIAL INFORMATION CASE STUDY

Material information



No.	Division (Layer Thickness)	Si_3N_4 T.C (W/m·K)		Remark
		Sintering	Brazing	
		Case 1	Case 2	
1	Top Cu (0.3mm t)	393	393	
2	Filler (0.005mm t)	398	398	AgCu
3	Ceramic (0.32mm t)	80	80	
4	Filler (0.005mm t)	398	398	
5	Bottom Cu (0.3mm t)	393	393	
6	Filler (0.001mm t)	100	398	Ag & AgCu
7	Pin Fin Cu (3.0mm)	393	393	

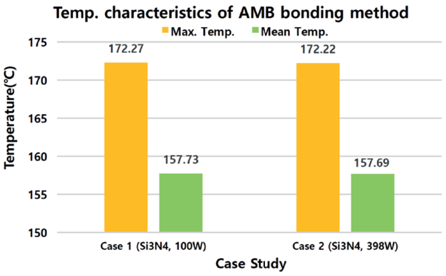
Interpretation conditions



No.	Items	Application
1	Method	Steady state
2	Ambient Temperature	25°C
3	Heat Information	- SiC Die Thickness: 0.5mm Heat Area: 10mm x 10mm - Output: 400W
4	Cooling fluid Information	- Inlet Temperature: 25°C - Glycol 50 - Flow Rate: 1 LMP

2. SINTERING TYPE VS. BRAZING TYPE RESULTS

Summary



<Consideration>

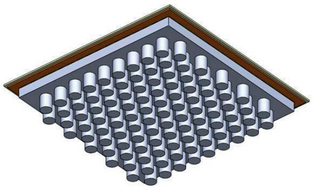
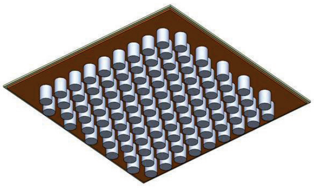
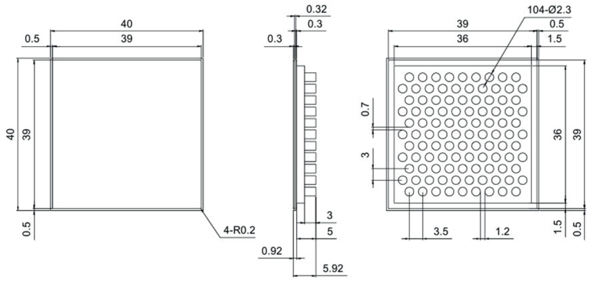
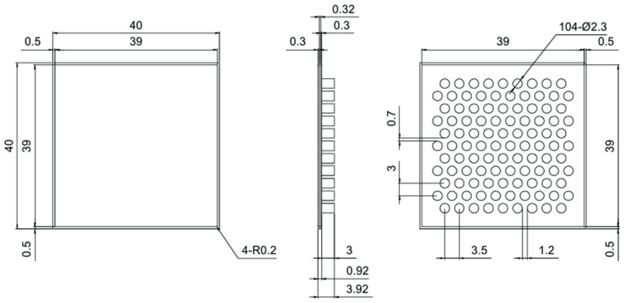
Sintering vs. Brazing – Equivalent Thermal Performance in Pin-Bonded AMB

Within the pin-direct-bonded AMB structure, the thermal simulation shows no significant difference between sintering and brazing as the pin bonding method.

Division	Max temp (°C)	Mean temp (°C)
AMB with Pin Fin (Sintering filler_0.1mm t_100W/m·K)	172.27	157.73
AMB with Pin Fin (Brazing filler_0.01mm t_393W/m·K)	172.22	157.69

1. REVIEW OF THERMAL ANALYSIS ACCORDING TO AMB HEAT SINK BONDING METHOD

- **Analytical model shape & objectives**
  : Review of thermal characteristics according to the Heat Sink bonding method to the AMB substrate.

AMB with Heat Sink		AMB with Pin Fin	
	Top Cu (0.3mm)		Top Cu (0.3mm)
	Si_3N_4 (0.32mm)		Si_3N_4 (0.32mm)
	Bottom Cu (0.3mm)		Bottom Cu (0.3mm)
	TIM (0.1mm)		Brazing Filler (0.01mm)
	Heatsink CU (5.0mm)		Pin Cu (fin 3mm)
			
- Heat Sink: Base Plate 2.0mm + Pin 3.0mm = 5.0mm - TIM Contact layer: 0.1mm (100µm)		- Pin Fin: 104-Ø2.3-3.0mm - TIM Contact layer: 0.1mm (100µm)	

2. AMB LAYER MATERIAL INFORMATION

- **Material information**

No.	Division (Layer Thickness)	Thermal Conductivity (W/m·K)		Remark
		TIM	Brazing Filler	
1	Top Cu (0.3mm t)	387.9	387.9	
2	Filler (0.005mm t)	393	393	
3	Si_3N_4 Substrate (0.32mm t)	80	80	
4	Filler (0.005mm t)	393	393	
5	Bottom Cu (0.3mm t)	387.9	387.9	
6	TIM & Brazing Filler (0.1mm & 0.01mm t)	10	393	
7	Heat Sink & Pin Fin (5.0mm & 3.0mm t)	387.6	387.6	

- **AMB with Heat Sink**

Top Cu (0.3mm)
Si_3N_4 (0.32mm)
Bottom Cu (0.3mm)
TIM (0.1mm)
Heatsink Cu (5.0mm)

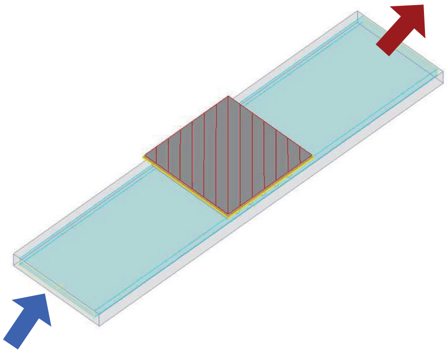
- **AMB with Pin Fin**

Top Cu (0.3mm)
Si_3N_4 (0.32mm)
Bottom Cu (0.3mm)
Brazing Filler (0.01mm)
Pin Cu (fin 3mm)

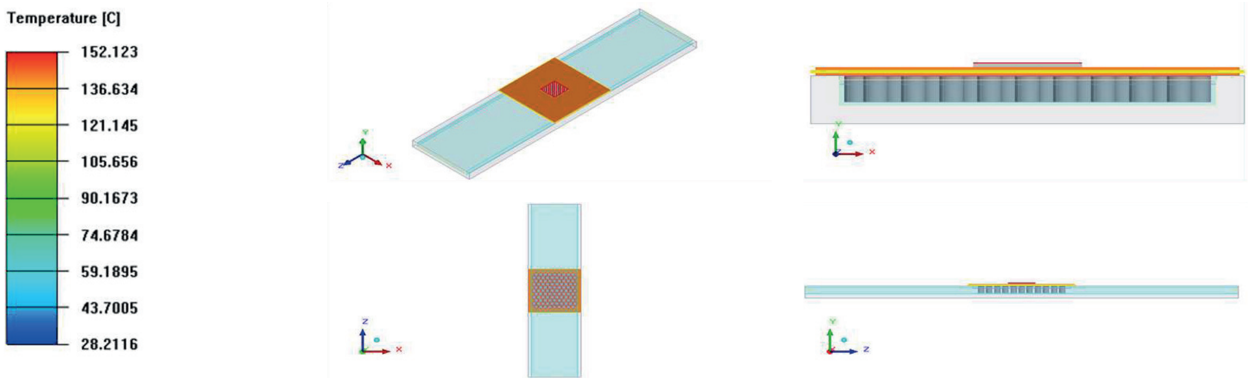
3. INTERPRETATION CONDITIONS

- **Interpretation conditions**

Heat Flux: 0.263W/mm^2
: 39mm x 39mm_Front Copper
and Assume 1:1 area

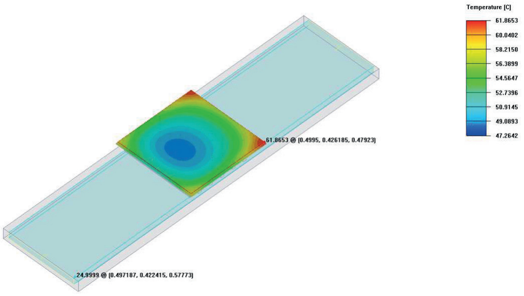


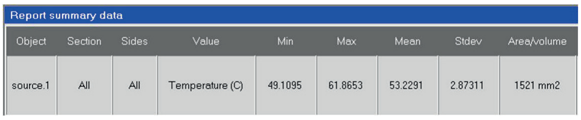
No.	Items	Application
1	Method	Steady state
2	Ambient Temperature	25°C
3	Heat Information	- SiC Die Thickness: 0.5mm - Heat Area: 39mm x 39mm - Output: 0.263W
4	Cooling fluid Information	- Inlet Temperature: 25°C - Glycol 50 - Flow Rate: 1 LPM



4. THERMAL ANALYSIS RESULT

AMB with Heat Sink

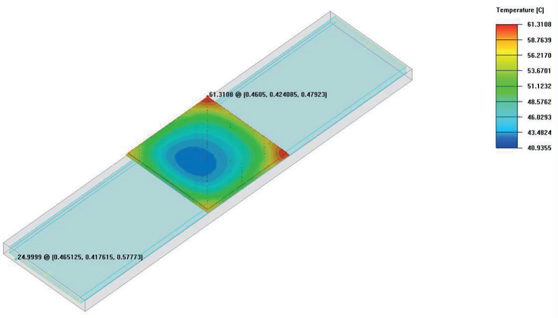


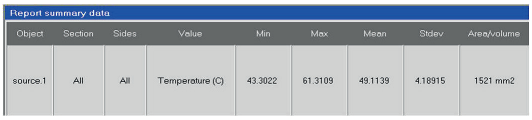

Report summary data

Object	Section	Sides	Value	Min	Max	Mean	Stdev	Area/volume
source.1	All	All	Temperature (C)	49.1095	61.8653	53.2291	2.87311	1521 mm2

AMB with Heat Sink
: AMB Substrate + TIM (0.1mm t _ 10W/m·K)

AMB with Pin Fin



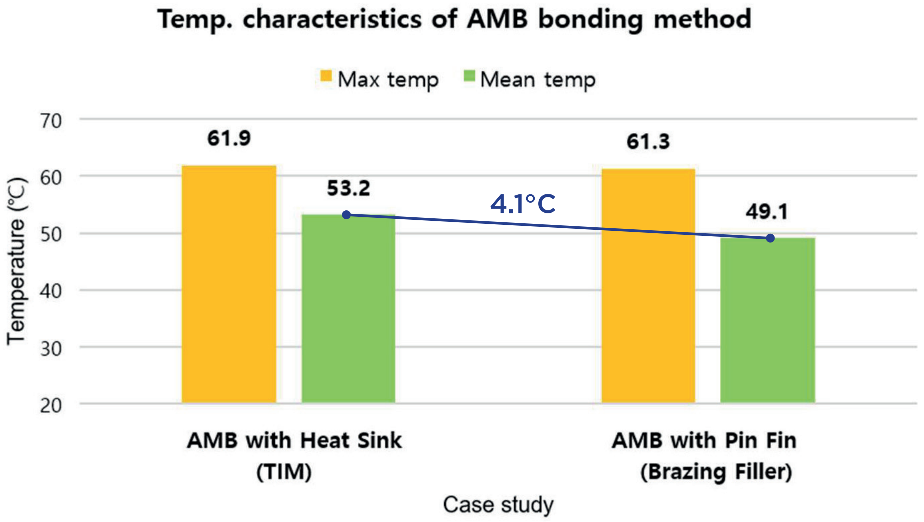

Report summary data

Object	Section	Sides	Value	Min	Max	Mean	Stdev	Area/volume
source.1	All	All	Temperature (C)	43.3022	61.3109	49.1139	4.18915	1521 mm2

AMB with Pin Fin
: AMB Substrate + Brazing Filler (0.01mm t _ 393W/m·K)

5. INTERPRETATION RESULT

- **Summary**



<Consideration>

- AMB with Pin Fin has 4.1°C cooling effect better than AMB with Heat Sink.
- If the SiC Die chip heat generation is High, the cooling effect is also improved
- Improving heat dissipation characteristics in thin structures

Warpage simulation is possible on the simulation team.

Division	Max temp (°C)	Mean temp (°C)
AMB with Heat Sink (TIM_0.1mm t_10W/m·K)	61.9	53.2
AMB with Pin Fin (Brazing Filler_0.01mm t_393W/m·K)	61.3	49.1