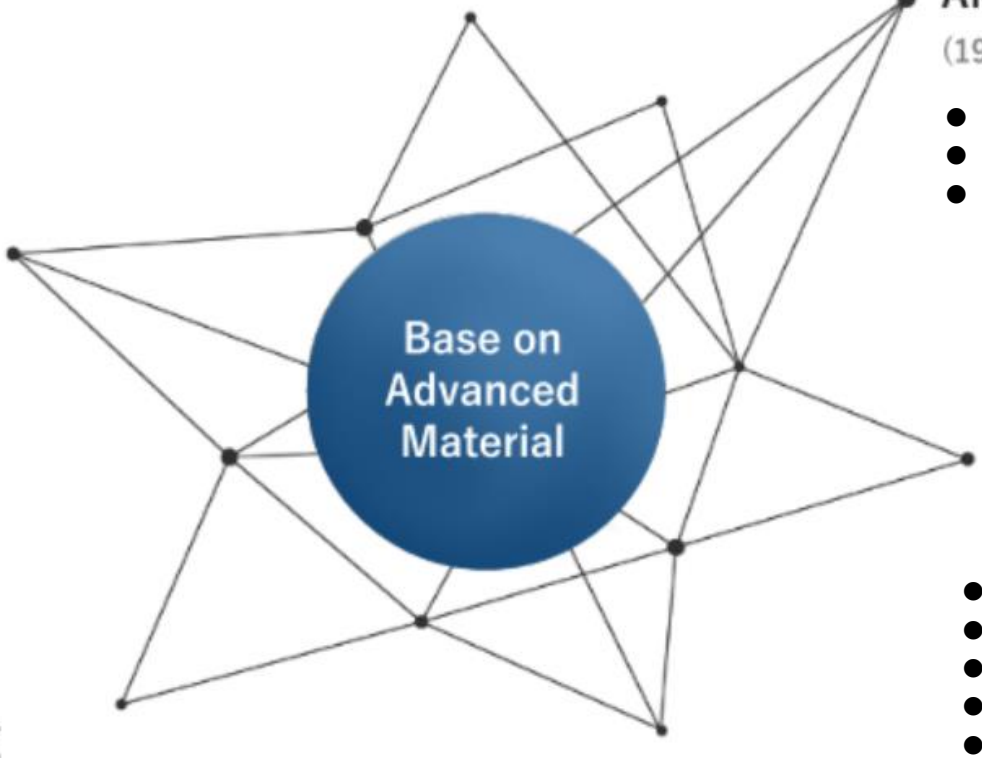

AMO
CORPORATE PROFILE
TRUSTED INNOVATION
TWE Solution

AMO GROUP IS BASE ON MATERIALS



IT/ Automotive

AMOTECH

(1994~)

- EMC
- Antenna
- BLDC Motor

Nano/ Energy/ Environment

AMOGREENTECH

(2004~)

- Amorphous Core
- Thermal Solution
- Nano Fiber
- Flexible Battery
- ESS

Sensor/ Module/ IoT/ 5G

AMOSENSE

(2008~)

- Wireless Charging
- Ceramic Substrate(AMB)
- IoT Device
- 5G AiP
- Radar Antenna
- LED Lamp

Bio/ Medical

AMOLIFESCIENCE

(2016~)

- Cell Culture
- Magnetic Beads
- Wound Patch
- Smart Skin
- Helth Care Device

ABOUT **AMO GROUP**

Based on the advanced material, Amotech has provided the competitive products in the IT, automotive, energy, and industry

FACT AT GLANCE

Incheon Headquarter in The Republic of Korea

352 Million(USD) Sales in 2018

35.5 Million(USD) R&D expenses in 2018

3,169 patents Patents as of December 31, 2018

1,445 employees Employees as of December 31, 2018

12 factories Production Site

AMO Group Business

4.2 Future Application

Automotive

Key Direction

Autonomous Driving | Connectivity | Safety | Convenience | Lightweight

- Antenna Solution for LiDAR, Radar & 5G
- Smart Key solution
- Pressure sensor
- EMI protection & Thermal solution

4.2 Future Application

Mobile Device

Key Direction

High Performance | Proprietary Material | Reliability

- RF Cable with Multi Layer Technology
- Substrate for 3D Sensing
- Low permittivity Heat radiation material
- Thin FPCB(COF) in Display
- Ceramic Back Cover
- Touch Pressure Sensor

4.2 Future Application

Energy & Environment

Key Direction

High Efficiency | Renewable | Stable Harvesting

- Solar & ESS power system
- AC/DC Inductor module
- Wireless Charging system & Sensor

4.2 Future Application

IoT

Key Direction

Smart Sensing | Ultra Low Power | Global Roaming

- Multi-layers design
  AiP (Antenna in Package)
  SiP(System in Package)
- Thin & Flexible Battery
- Sigfox module

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4.2 Future Application

Life Science

Key Direction

Precision Medicine | POCT | ICT convergence

- Cell therapy products through 3D cell culture
- Diagnostic equipment using magnetic bead
- Biometric information sensing Wearable Device

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Contents

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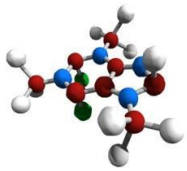
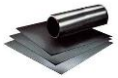
Amogreentech Thermal Solution

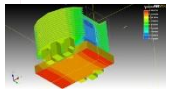
Thermal
Materials

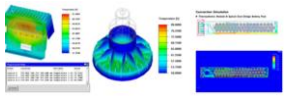
Thermal
Design

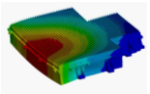
Thermal
Simulation



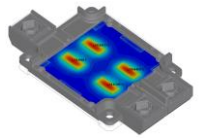








Solution



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Thermal Material

Thermal Material

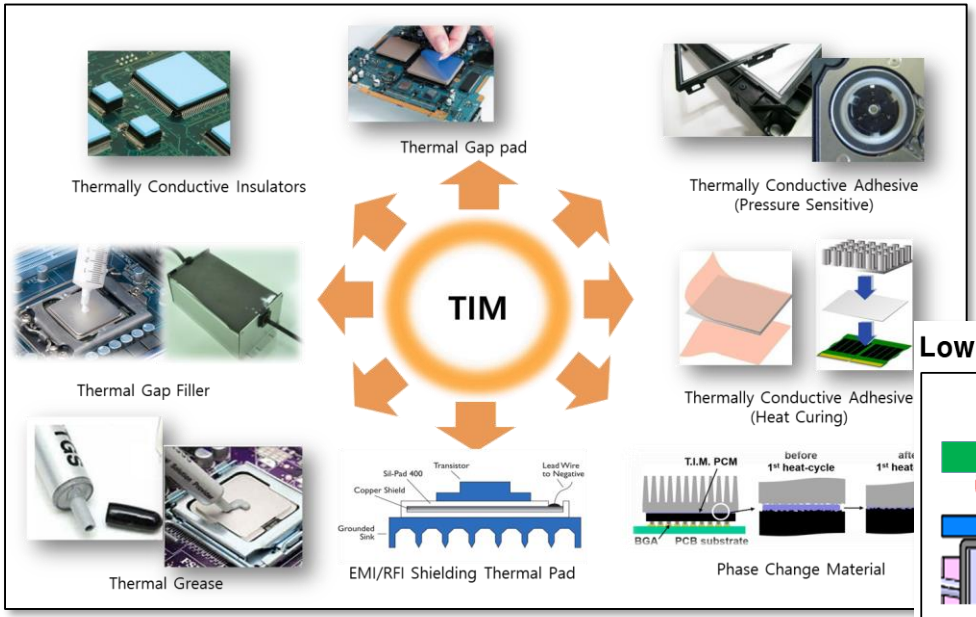
1) Thermal Conduction Material

$$\dot{Q}_{cond} = kA\frac{T_h - T_c}{L}$$

Cu		*k* = 400 W/mK t = 5~100um With Thermal Adhesive	Stamping	Mobile Telecom. EV
Graphite		*k* = 2000 W/mK t = um With Thermal Adhesive	Stamping	Mobile Telecom. EV
RF Thermal Sheet(5G)		*k* = 60 W/mK t = um Permittivity = 3	Stamping	Mobile Telecom
Thermal Plastic		*k* = 2 ~ 30 W/mK t = 5~100um With Thermal Adhesive	Injection Molding	Mobile Telecom. EV
Ag Paste		*k* = 200~ 300 W/mK Viscosity 40~100 kcps Conducting Filler = Silver	Injection Molding	EV Power Module

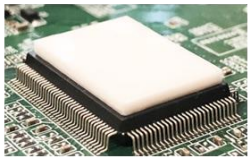
Thermal Material

TIM(Thermal Interface Materials)



Acrylic TIM

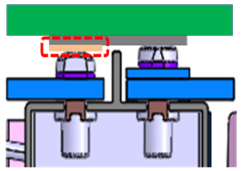
AVN



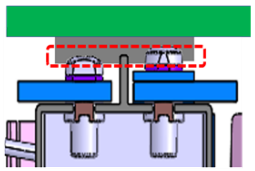
- Silicone & Oil Bleeding Free
- No Electrical Short Problem

Low Restoration TIM

General TIM



Low Restoration TIM



- Component Stress
- Minimal Component Stress
- Low Thermal Resistance

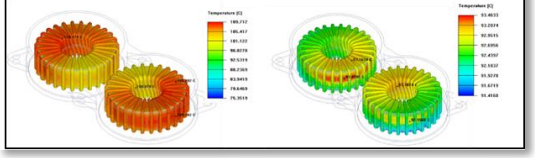
Low Viscosity Liquid Molding

EV Battery

- EV Battery Cooling
- Charge & Discharge Efficiency ↑

Thermal Molding Gel

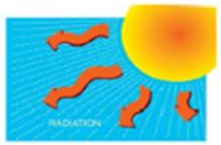
PFC Module



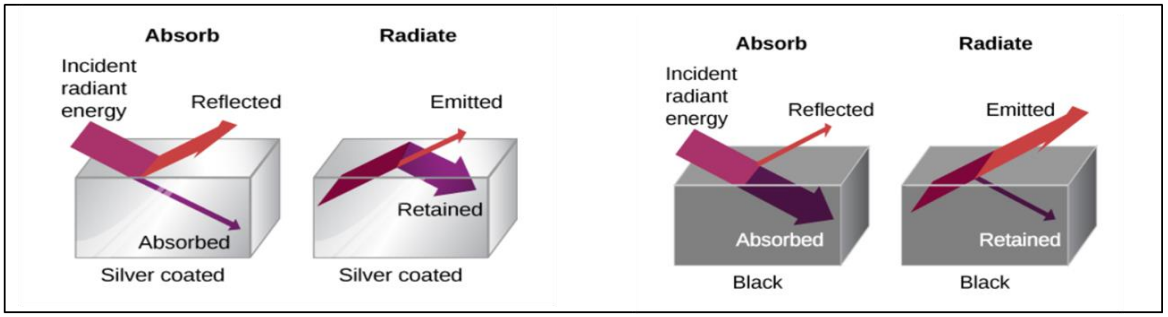
Thermal Material

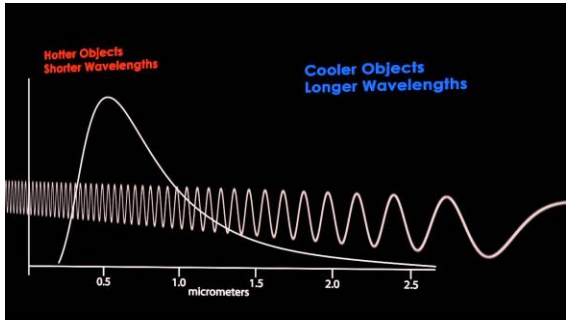
방사코팅

2) Thermal Emission Material



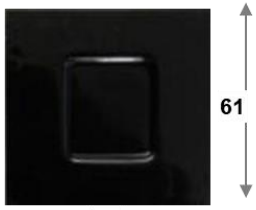
$$\dot{Q}_{rad} = \varepsilon\sigma A\left(T^4_{surface} - T^4_{surround}\right)$$



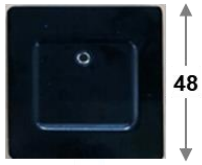


Temperature variation before/after spreading coating on the surface

bare



R-coated



R-coated (downsized)

	bare	ε-coated
Surface.LED (°C)	107.8	79.3
Temp. lowered (°C)	-	▽28.5
Surf. Area (mm²)	4.270	4.270 (the same)
Dimension (mm)	70 x 61	70 x 61

downsized
106.0
▽1.8
2.640 (▽38%)
55 x 48

▣ Spray Coating

▣ Dip Coating

▣ Powder Coating

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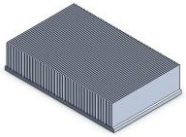
Thermal Parts

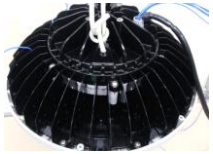
Thermal Parts

1) e-Heat sink

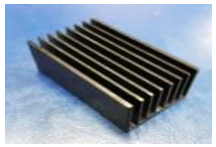
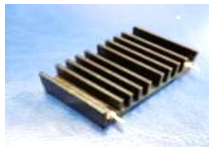

Automotive
Head lamp, HUD,
Module case etc.

Industry
Large size heat sink

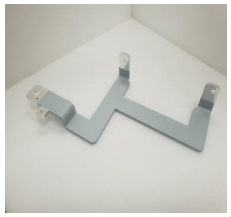
Lighting
LED lamp, Tunnel lamp

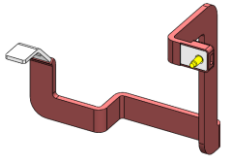
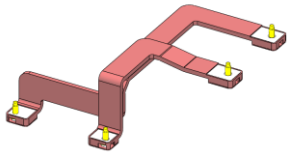
Appliance
Washer, Refrigerator

Heat sink material	Al, Cu, Mg, etc.
Manufacturing process	Extrusion, Die-casting, Fin-press in, etc.
Manufacturing process	Spray, Dip, Powder coating, etc.
Surface process thickness	20 ~ Hundreds of ㎛

2) e-Bus bar




Automotive
Junction box,
Battery pack,
Inverter
Converter
Gateway
etc.

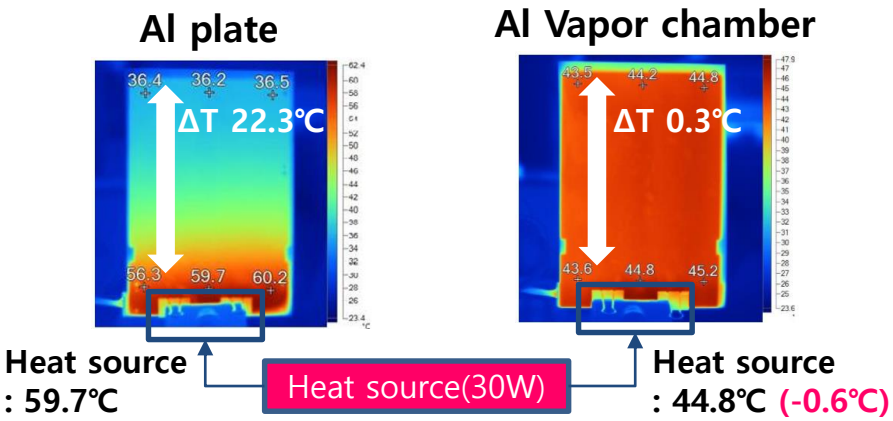



Industry

Bus bar material	Cu, Al, Brass, etc.
Manufacturing process	Stamping
Manufacturing process	Spray, Dip, Powder coating, etc.
Insulation/Flammability characteristics	40kV/mm (ASTM D149) / V0 (UL94)

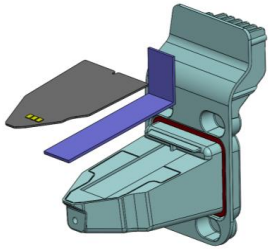
Thermal Parts

3) Vapor chamber (Heat pipe)

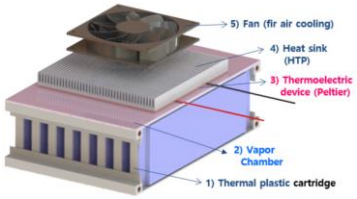


Application

Mobile



(LED lamp)



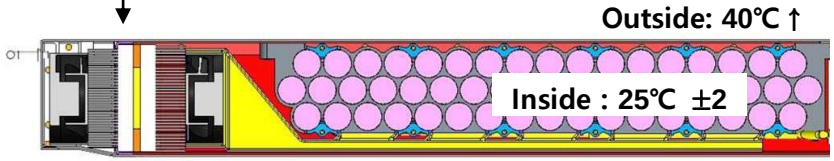
(EV battery module)

Automotive

4) Peltier

Application

- Mini Refrigerator
- Water dispenser
- Cold Chain Carrier
- ESS cooling

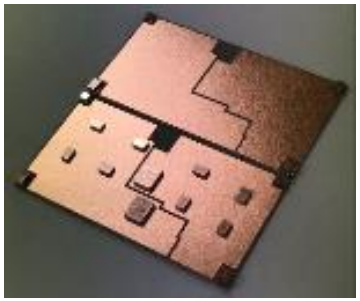


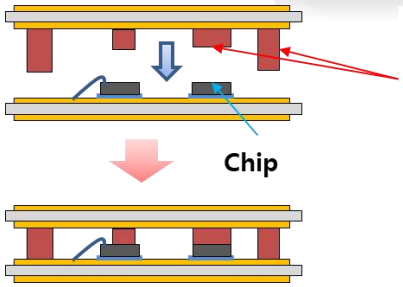
5) Fan / Water Pump

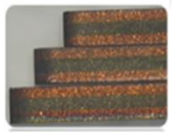
Thermal Parts

6) Ceramic substrate

Key Tech. _ CQC Spacers & Poles for DSC

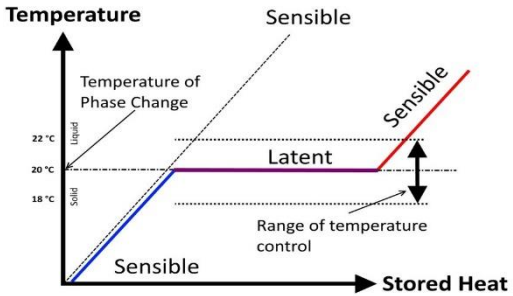




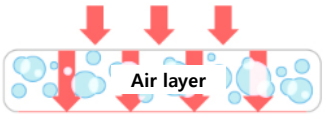


	CQC	Cu	Chip
Material	Cu/Mo/Cu Cu/Cu-Mo/Cu	Cu	Si/SiC/GaN
CTE(ppm/℃)	7~12	17.6	2.5, 3.5
T.C.(W/m-K)	170~	~400	
Thickness	Variable Thickness is Possible Depending on Customer's Request		

7) PCM (Phase Change Material)

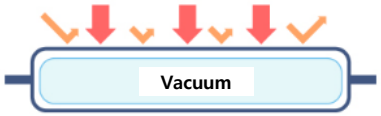


8) VIP (Vacuum Insulation Panel)



Normal Insulator

Heat transfer by micro air layer



Vacuum Insulator

Internal vacuum block conduction and convection Radiant heat is reflected by Aluminum container

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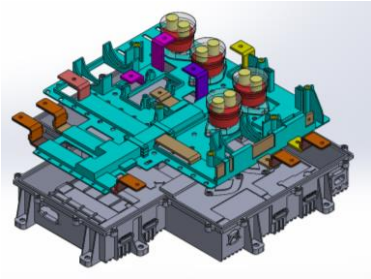
Thermal Module

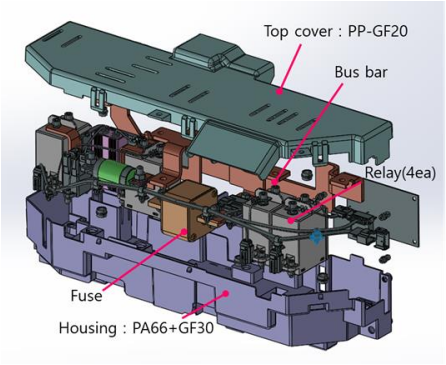
Thermal Module

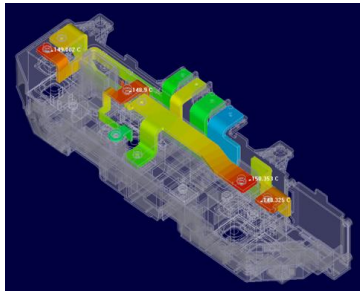
1) EV Relay junction box

① EV Junction box

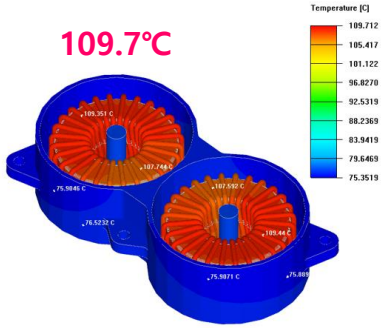


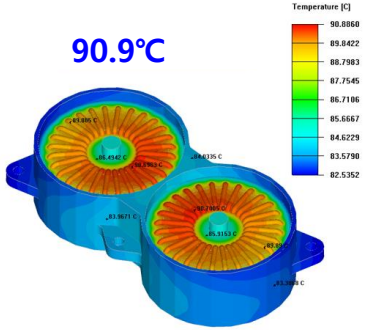
② PRA

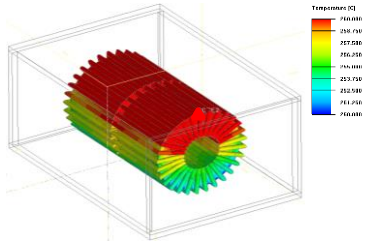


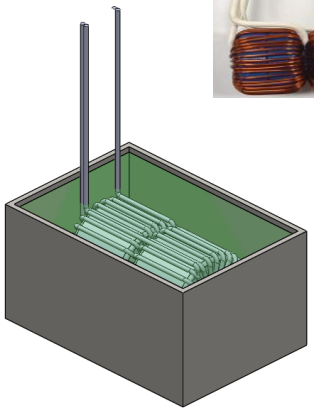


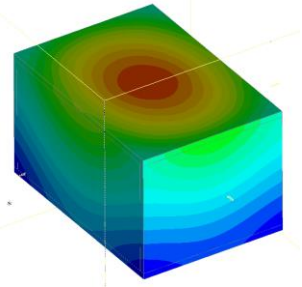
2) PFC Module









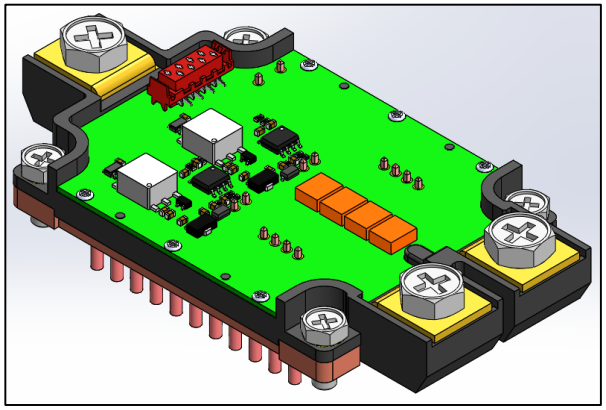


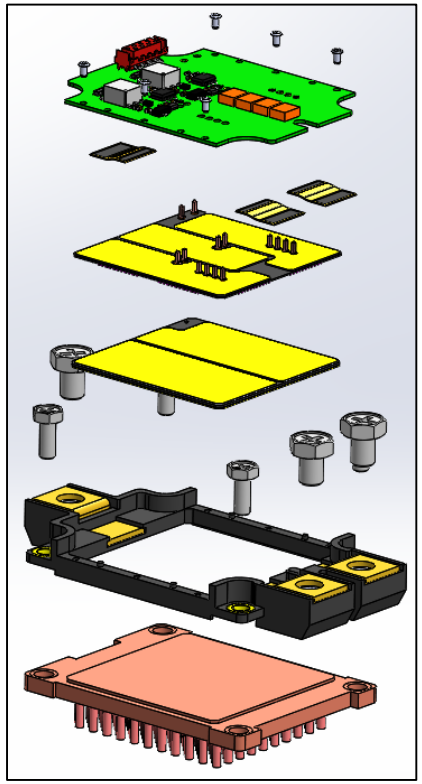
Thermal Module

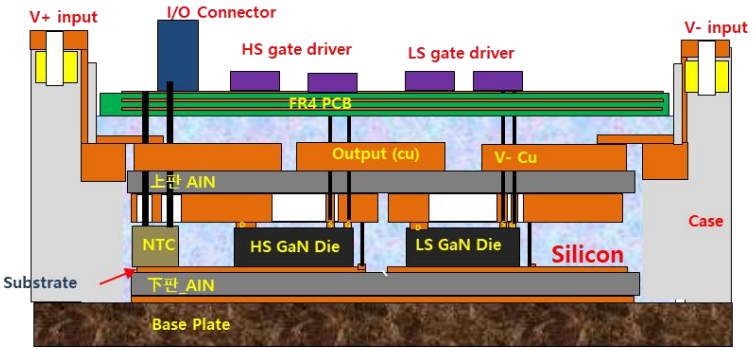
4) Power Module for EV

Double Side Cooling Power Module Solution

- ❖ High Power SiC & GaN Semiconductor Power Module for xEV
- ❖ **AMB Substrate & Ag nano Paste(Film) & Spacers for SiC & GaN**
- ❖ **TIM & Heat Sink Solution by Materials & Design**





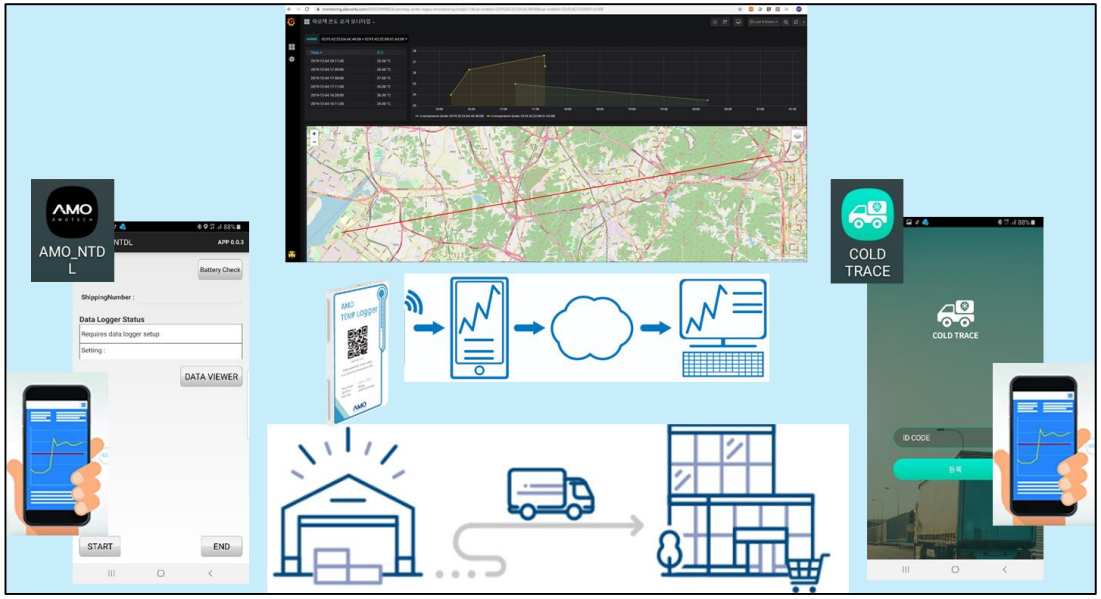


Thermal Module

5) Cold chain System & Carrier

Cold Chain System

Transmit and receive records like temp., humidity, GPS, vibration, etc. through Data logger.

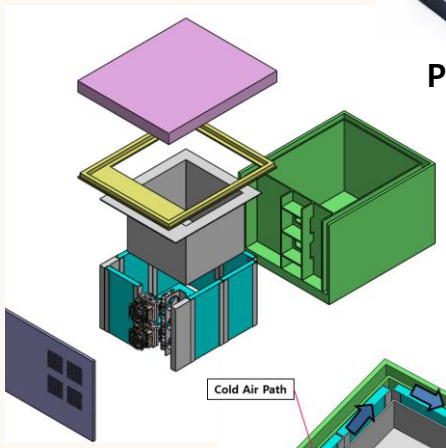


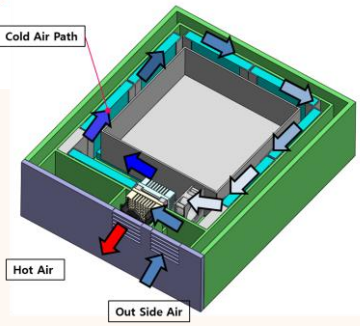
Peltier Active Cooling Carrier

PCM

VIP

Peltier

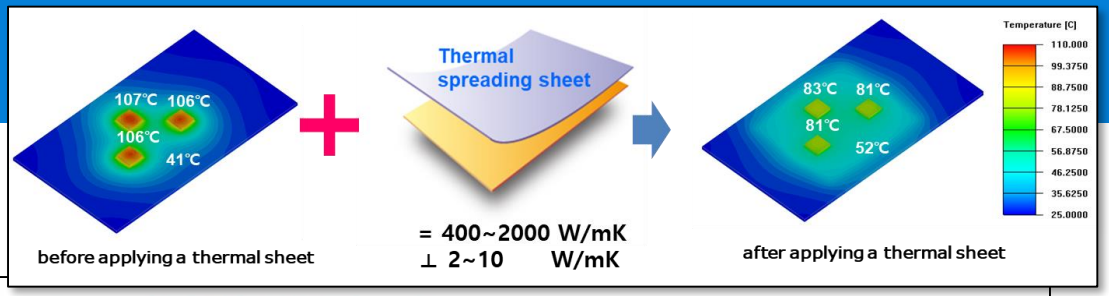




AMO
AMOGREENTECH

Application

Mobile(5G)



LCD/OLED Panel

Heat dissipation
On Panel surface
And Component

WPC+HTMS

Wireless charging coil
of Heat dissipation

PCB

SIM and Shield Can
of Heat dissipation

NFC+HTF

Heat dissipation of
NFC Antenna

Bracket

Heat dissipation on
PCB and Case Contact
surface

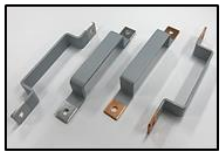
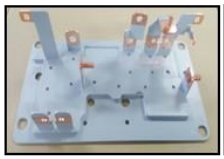
Rear Cover

Skin contact area of
Heat dissipation and heat insulation

Battery Case

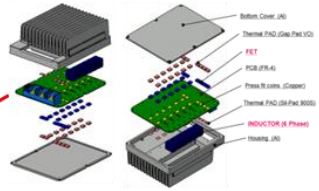
Battery surface
of Heat dissipation

EV Thermal Solution

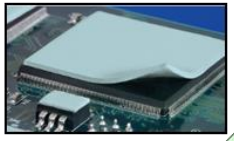



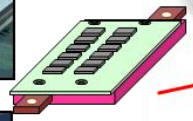

Relay J/B
- ε - Cu Bus Bar
- ε- Al Bus Bar
- Thermal Plastic
- TIM


Charging & ESS
- ε- Bus Bar
- Thermal Plastic
- TIM

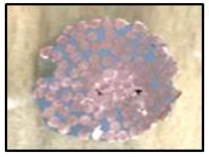


DC-DC Convertor/Invertor
- ε- Bus Bar
- Thermal Plastic
- TIM

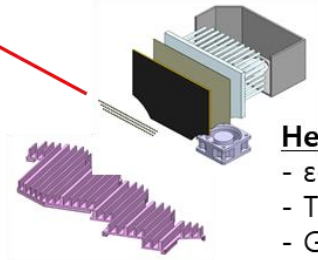




Battery
- ε- Bus Bar
- TIM
- Thermal Plastic
  Cell Cartridge

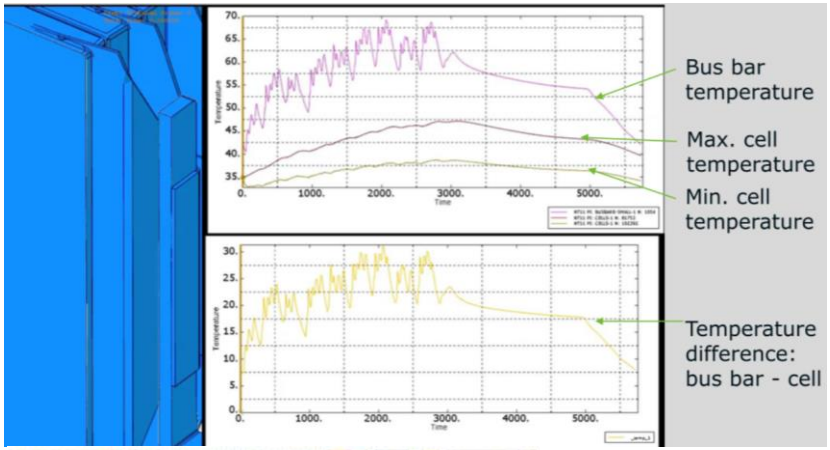


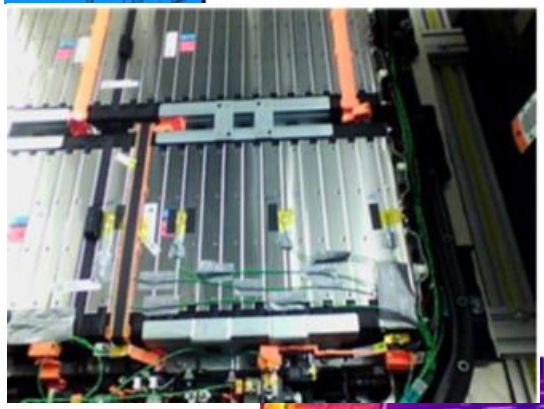

EV Motor
- Thermal Impregnation
- BMC Molding

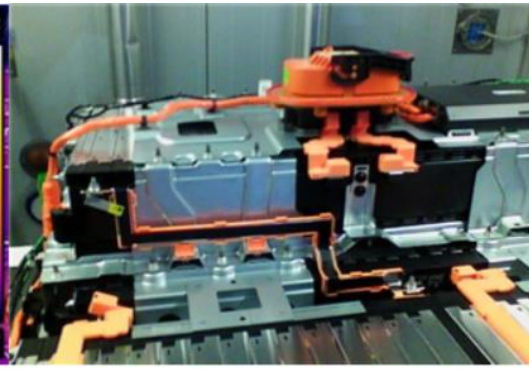


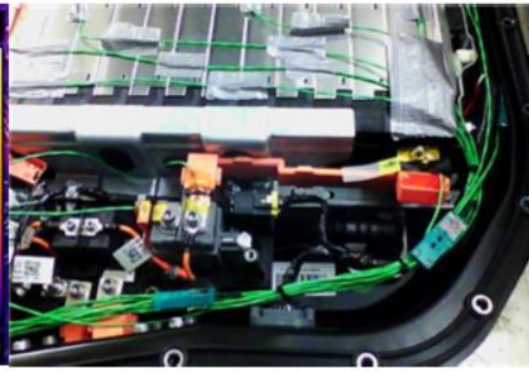
Head Lamp
- ε- Coating
- Thermal Plastic
- Graphite TIM

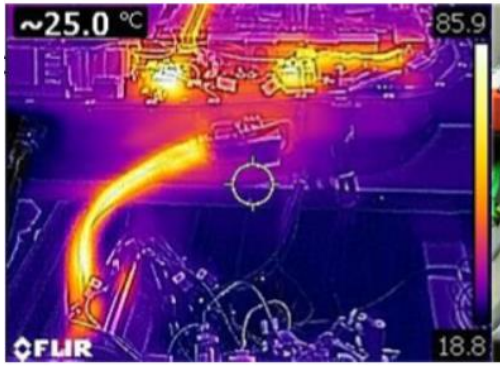
ε – Bus Bar Thermal phenomenon

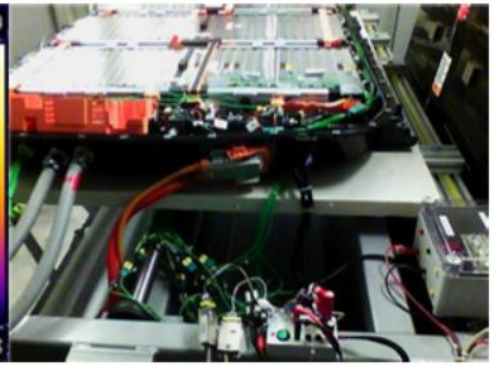












1. ε – Bus Bar @ EV

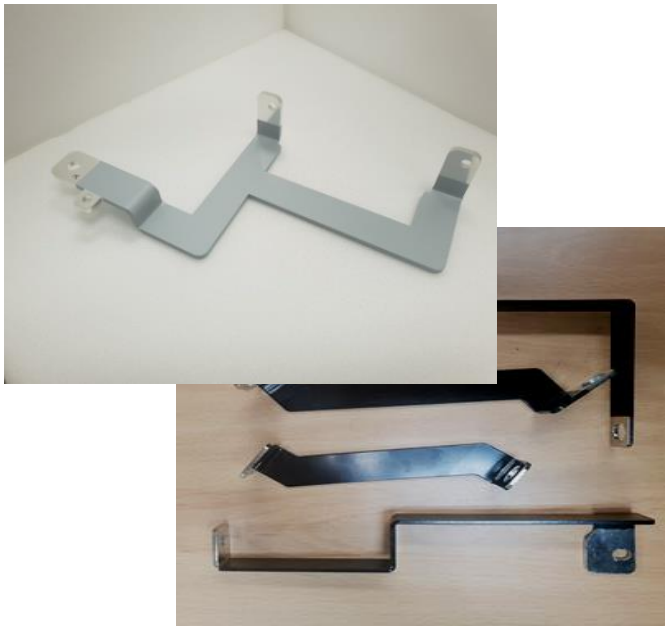
PCT/KR2016/003745 & 5others

Core Technicnology

e-Bus Bar = Bus Bar + e-Heat Sink performance

e-Bus Bar

Thermal Emission Coated Bus Bar



=

Performance

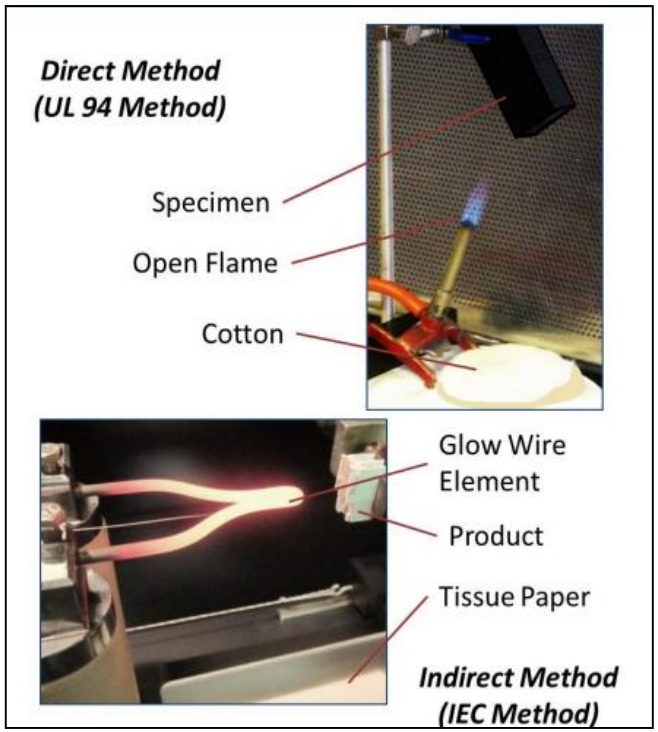
Electric Conductor

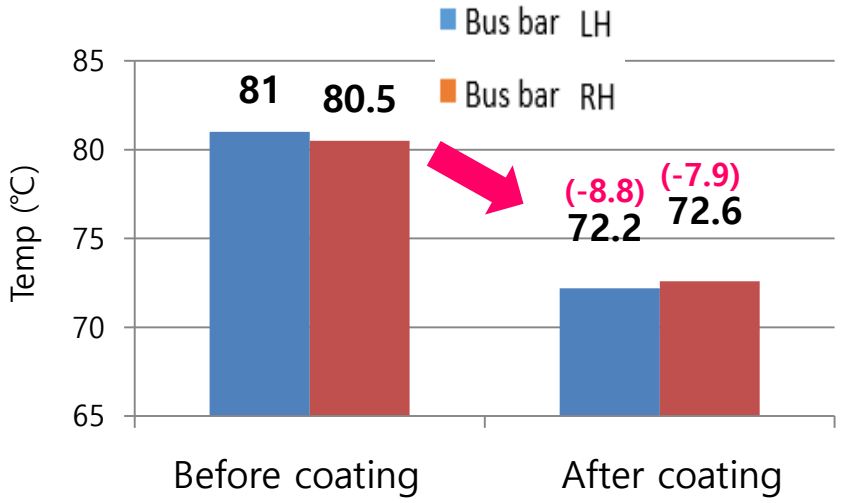
+

Heat dissipation
(Heat Sink Performance)

1.1 ε – Cu Bus Bar Merit

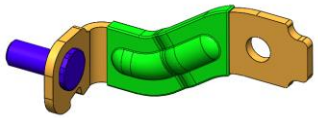
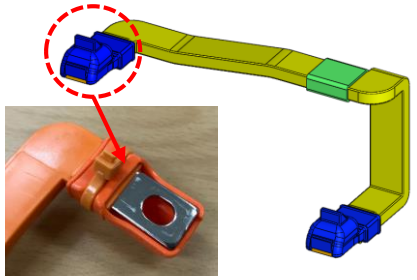
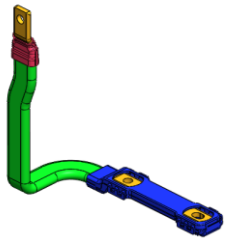
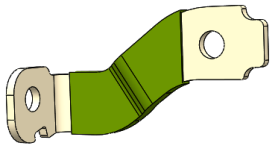
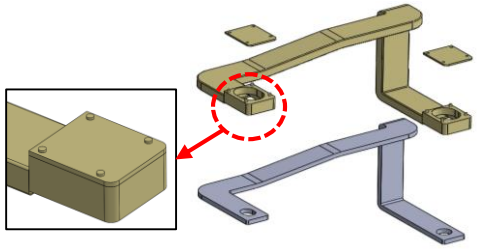
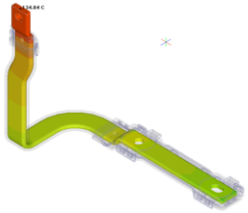
Merit of e-Cu Bus Bar





Properties	Value	Test Method
Flammability	V-0	UL94
	950±10℃	EC 60695-2-12 (Glow Wire Testing)
Specific Gravity	1.4±0.1	-
Impact Resistance	≥1kg/30cm	ASTM D2794 (Dupont impact tester)
Glass Transition Temperature(Tg)	≥100℃	DSC
Volume Resistivity	10^{16}Ω-cm	IEC 60093
Breakdown Voltage	40kv/mm	ASTM D149
Thermal conductivity	0.325W/mk	LFA

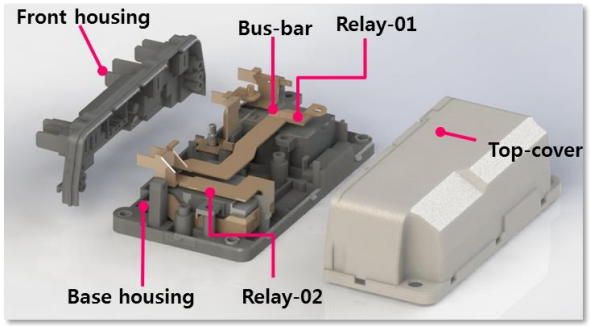
1.2 Bus Bar Thermal Solution

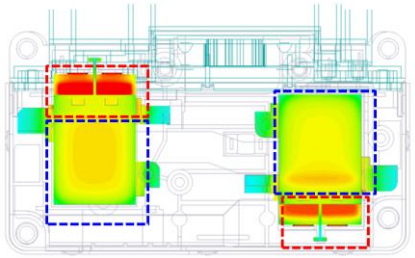
	PSDB adapter bus bar	Bus bar with Insert injection	Bus bar with shrinkable tube
Default	 Bus bar material : C2680 Surface process : Epoxy coating	 Bus bar material : C1100 Surface process: PP insert injection	 Bus bar material : A6101-T7 Surface process : Shrinkable tube, Insert injection
Current Temp.	**104.68℃** (Ambient temp. 95℃)	**83.32℃** (Ambient temp. 45℃)	**161.55℃** (Ambient temp. 60℃)
Solution	 Bus bar material : Al6061 Surface process : Thermal plastic (3W/mK)	 Surface process : Thermal plastic (3W/mK) **Design improved → Assembly(cost) improved**	 Surface process : Thermal plastic (3W/mK) **Cost reduction by using an insulation material**
Improved Temp.	**101.92℃** (-2.76)	**74.87℃** (-8.45)	**134.84℃** (-26.71)

2. High heat dissipation Relay Junction Box @ BEV

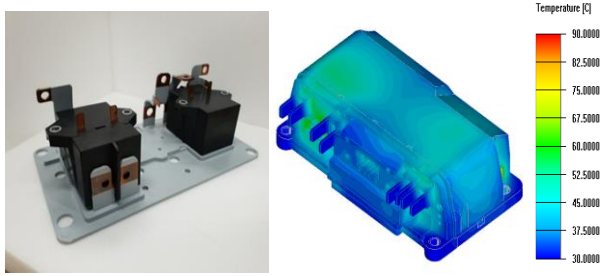
EV RJ(1) EV RJ(2)

Case 1)



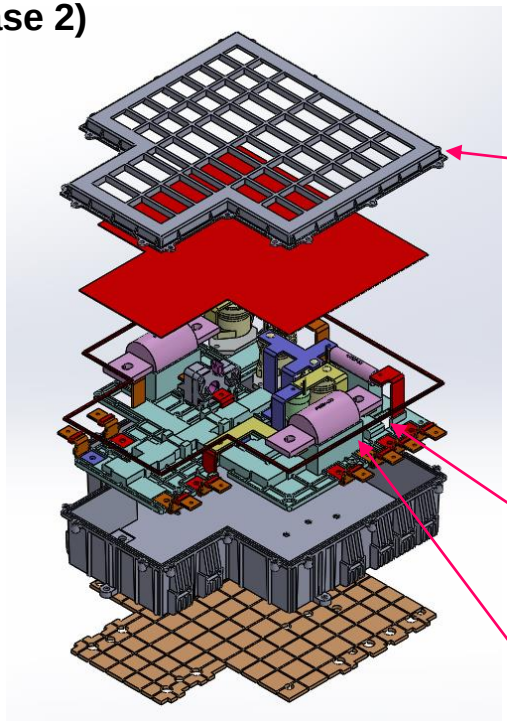


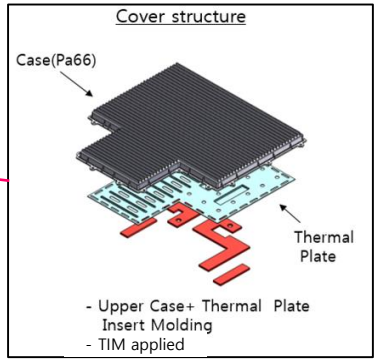
[Surface temp. of Relay bottom case]

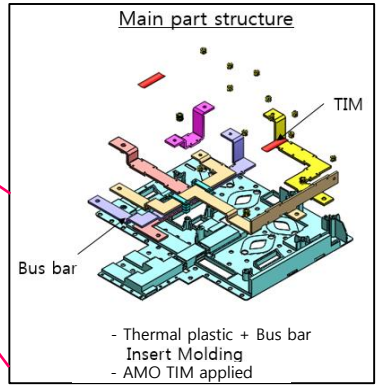


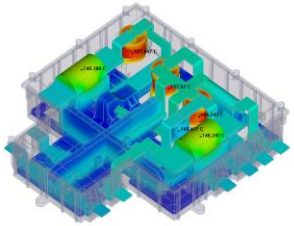
88℃ ▶ 74℃

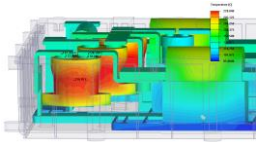
Case 2)

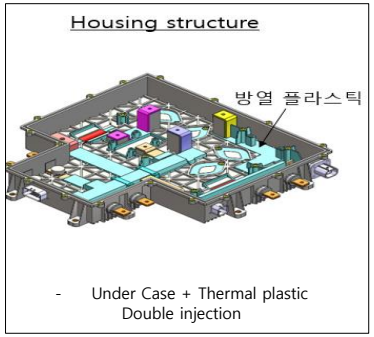






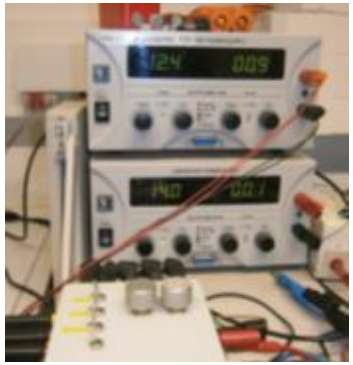






220℃ ▶ 130℃

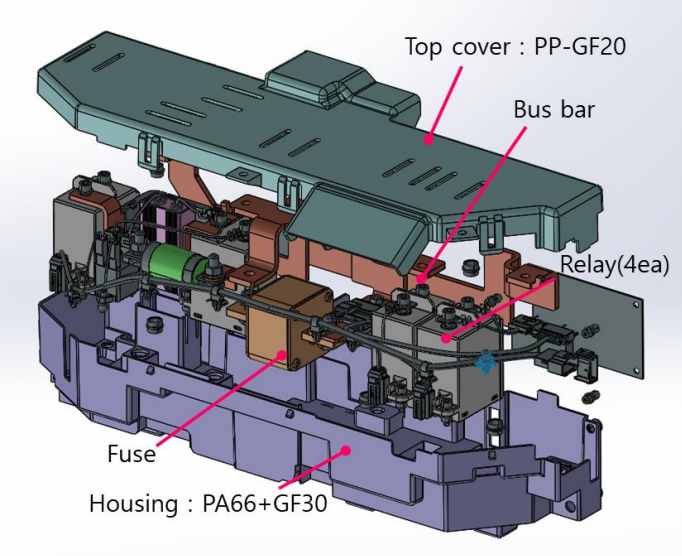
2.1 AMO Relay Junction Box Module Thermal Test



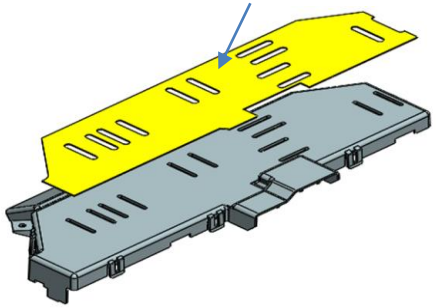
Test Result

150A	B1	B2	B3	B4	B5	B6	B7	B8	B9	R1	R2	P1	P2	In	Out
Default oHP_oWLP_2,5W-mK	82.27	81.48	82.44	**88.29**	84.71	85.32	84.63	85.41	84.80	80.52	83.05	75.90	56.26	51.81	20.74
HP40_mit WLP_5W_Insert molding_aufgefuellt (HP40_mit_WLP_5W insert molding_filled)	74.24	68.57	69.70	**74.06 (-14.23)**	71.27	75.11	77.82	75.11	73.37	80.26	78.43	59.75	47.27	50.06	24.75

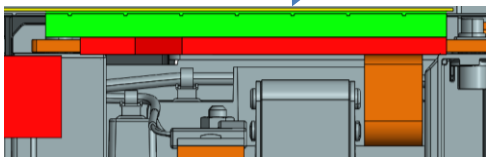
2.2 PRA(Power Relay Ass'y) for BEV Thermal Design

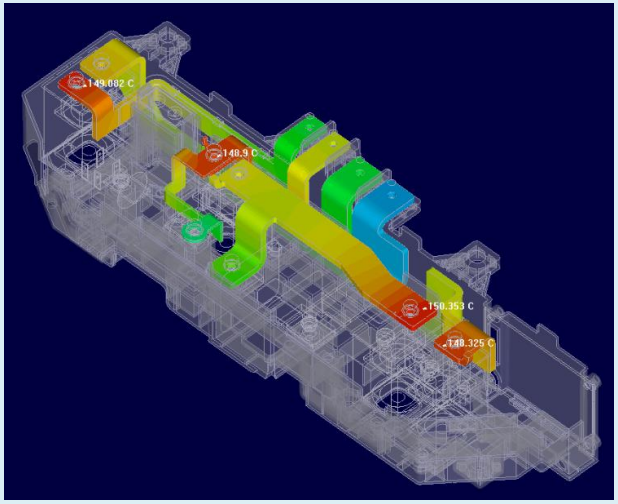


Thermal plate Insert Molding with Thermal plastic

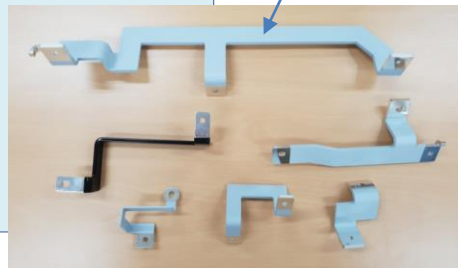


TIM(Thermal interface Material)

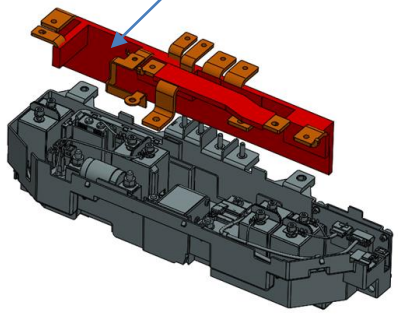




Bus e- Bus bar



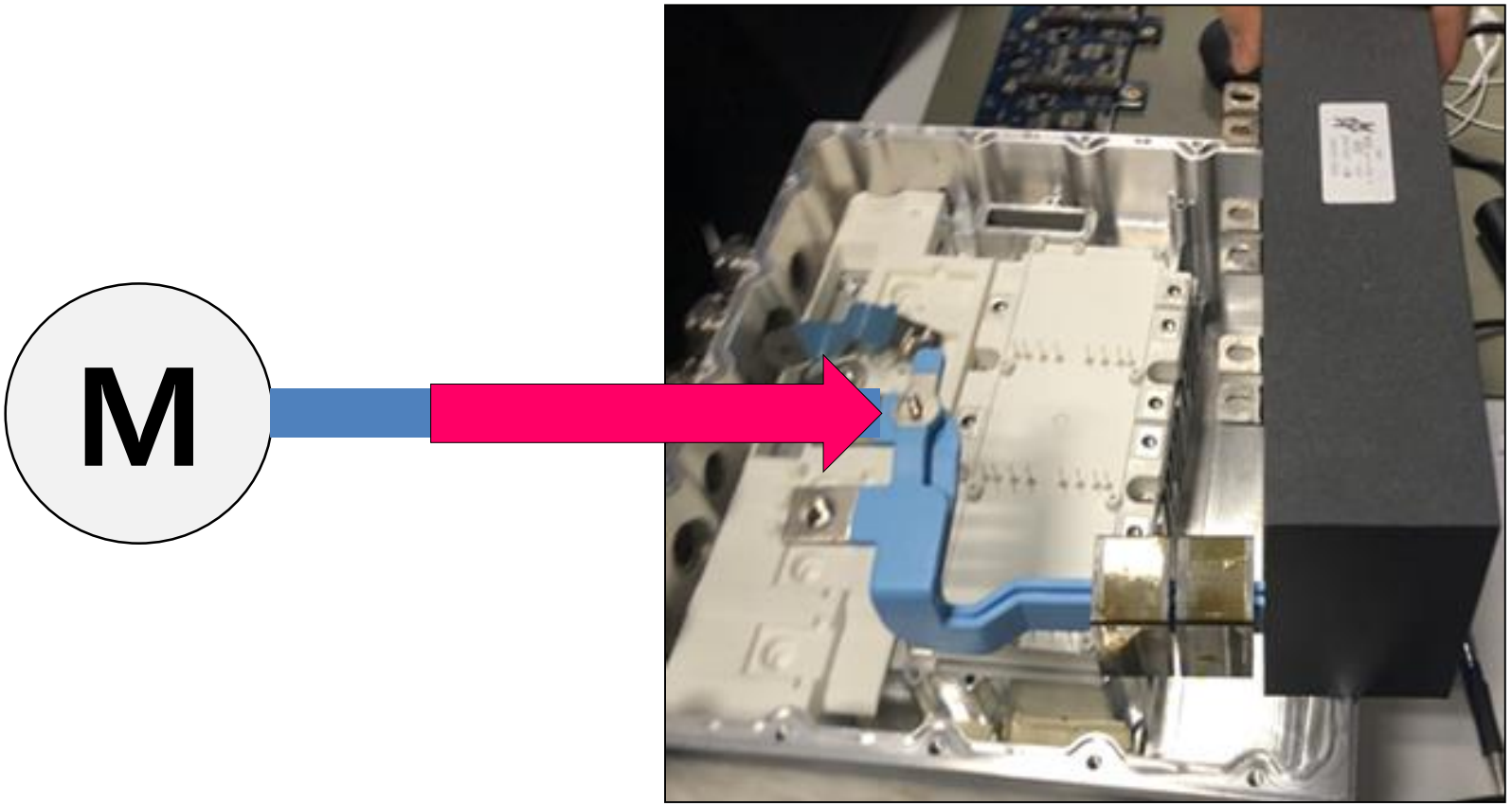
Bus Bar Insert Molding
with Thermal plastic



3. DC LINK CAPACITOR Thermal solution

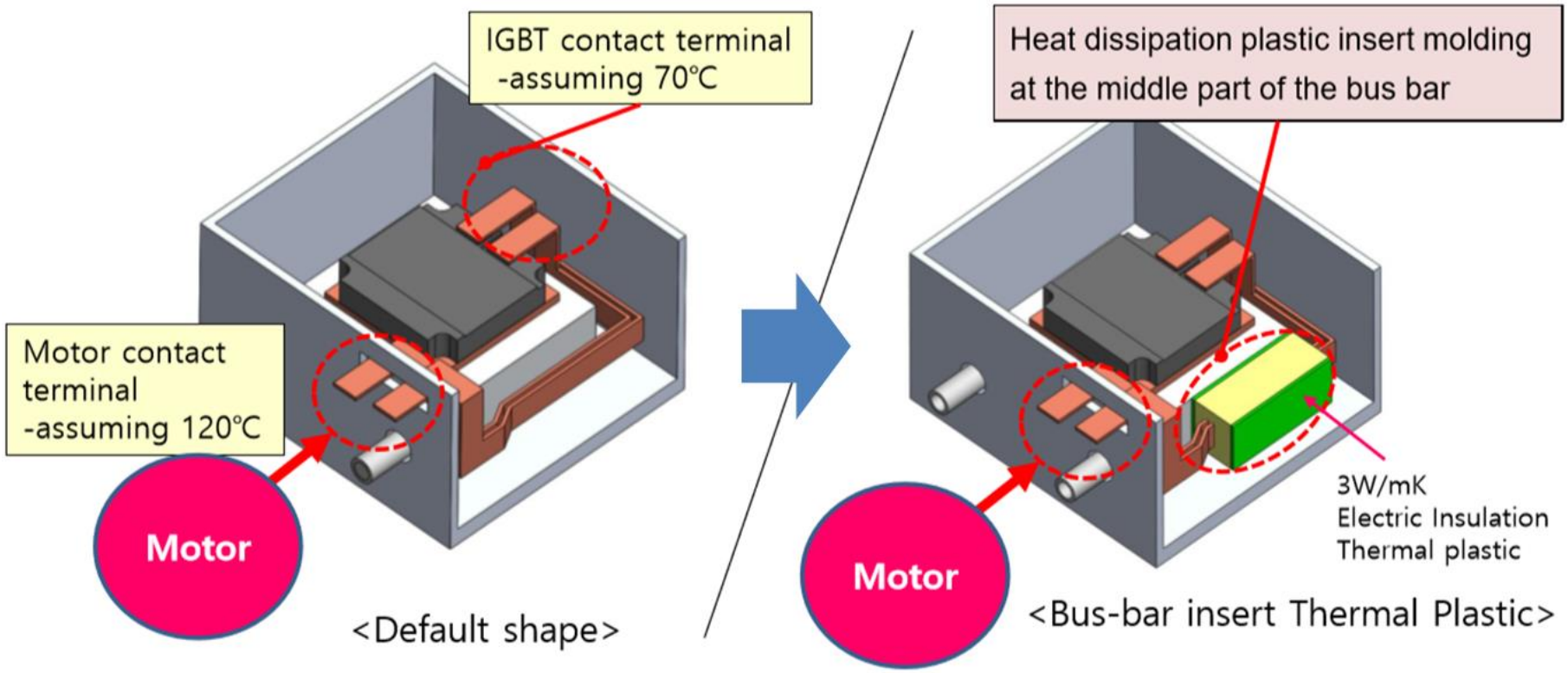
Core Technicnology *Heat Barrier & Dissipation Solution of Thermal Plastic*

ISSUE : **Counter-current flow of a Motor's Heat to IGBT module in DC link capacitor**



3.1 Solution : Bus Bar insert molding Thermal Plastic

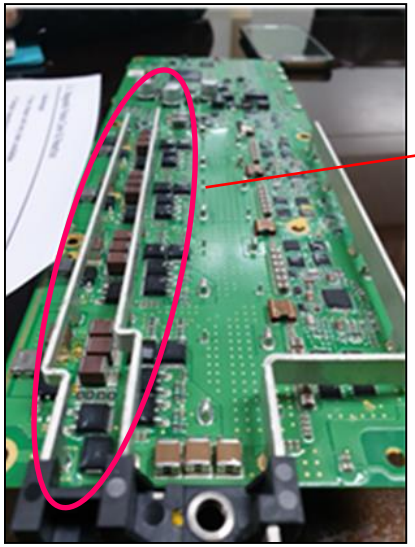
Thermal Solution

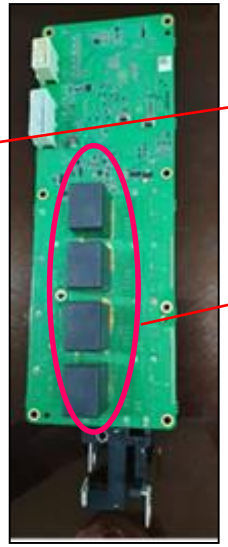


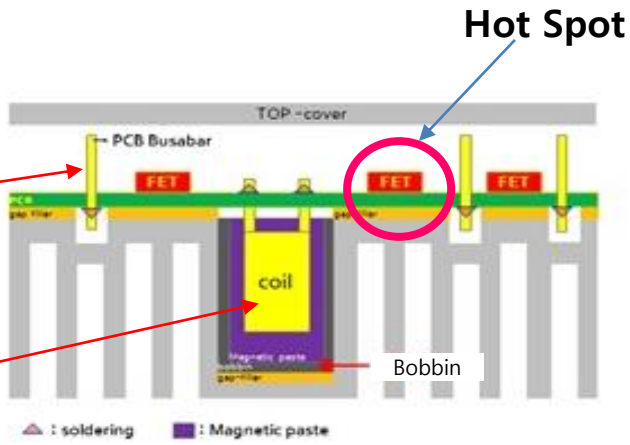
Result

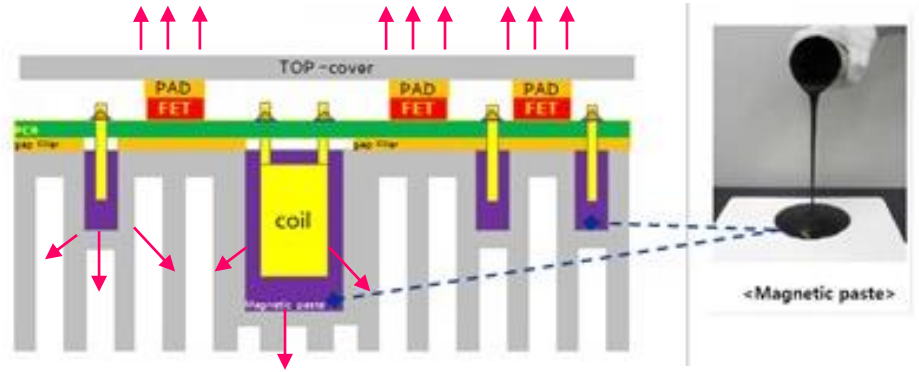
	Bus bar Temperature measure point & results [℃]				
Check Point	①	②	③	④	⑤
	Motor Contact	Front	Middle	Rear	IGBT Contact
Default	**120**	**94.3**	**86.6**	**80.9**	**67.1**
Solution	**120**	**73.4** (-20.9)	**57.2** (-29.4)	**54.8** (-26.1)	**54.7** (-12.4)

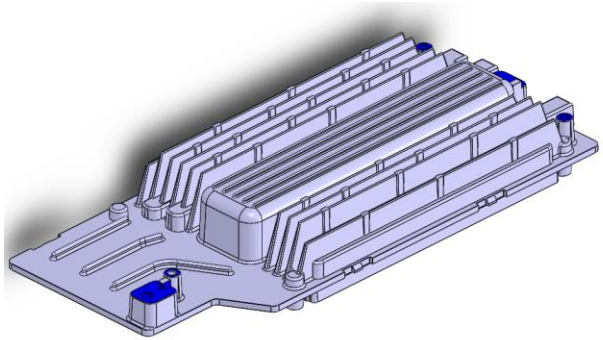
4. 48V Converter Thermal & Noise Solution





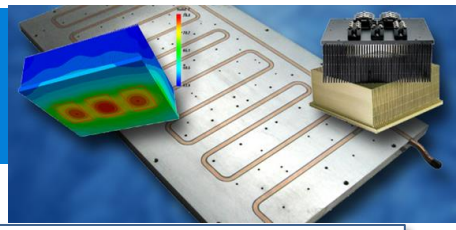


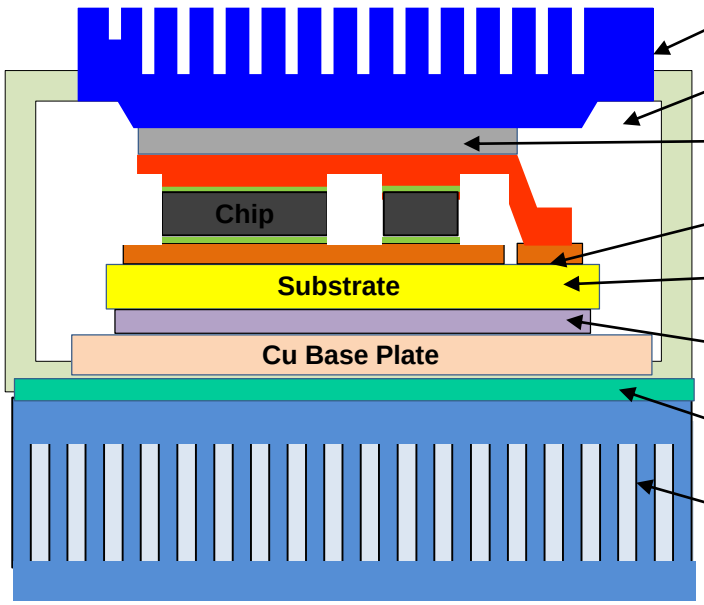




- Out Put Inductor – Thermal & Noise solution
- Bus bar – Thermal & EMI filer
- Soldering process – 1/2, Cost ↓

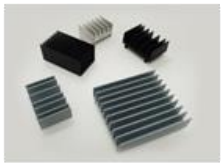
5. DSC(Double Side Cooling) Power Module





- Case : **Thermal Plastic**
- Molding : **TIM & Thermal Molding**
- Substrate : **LTCC**
- **Circuit design**
- Substrate : **AMB, Ceramic Interposer**
- Solder : **Nano Ag Paste**
- Thermal Pad : **TIM**
- Water Cooling : **e-Heat sink, Cooling plate**

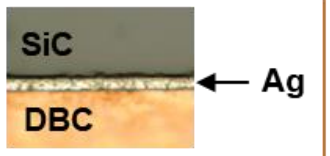
e-Heat sink
Thermal radiation coating



TIM
Thermal conductive
Grease/Pad

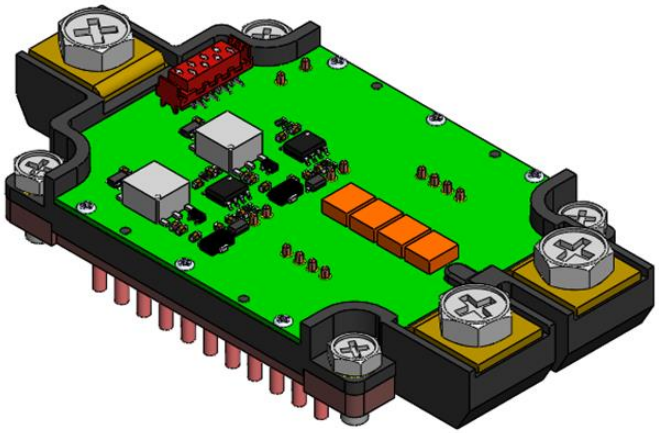
Substrate
Ceramic substrate
(AMB/DBC)

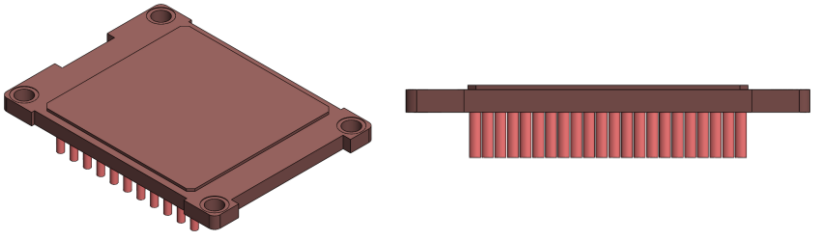
Nano Ag sintering paste
(200W/mK)

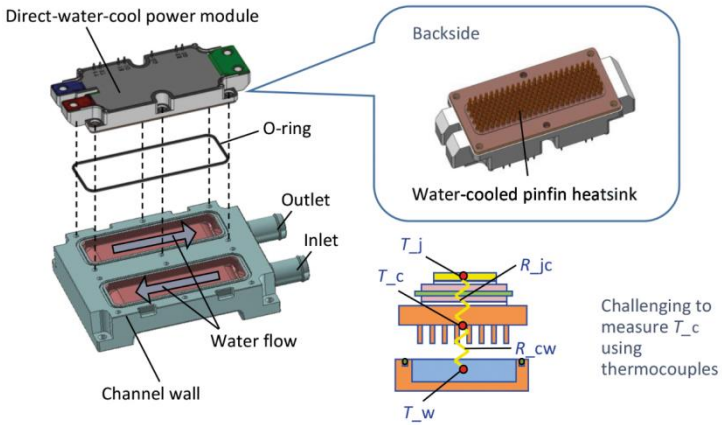


Plastic Cover
Thermal plastic
(1~30W/mK)

5.1 GaN Systems Power Module Thermal Solution

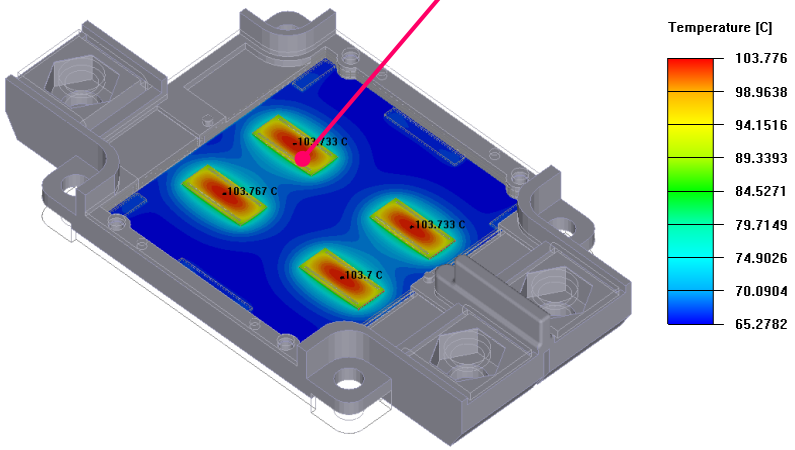






GaN Chip Max Temp.(Thermal Solution)

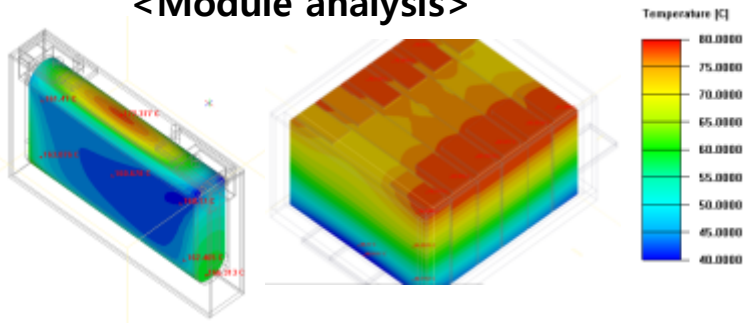
GaN Max Temp : 1200℃ ▶103.8℃



6. EV Battery Cooling Solution

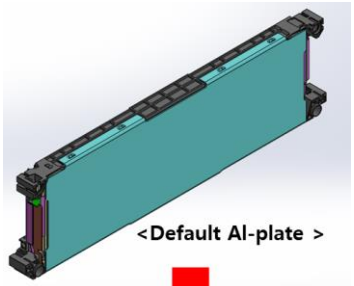
- Heat generated by the battery cells through the TIM is transferred between cells and through the cell floor to the outside
- Heat-discharge solution using thermal plastic cartridge and Vapor Chamber to conduct heat to the coolant plate

<Module analysis>

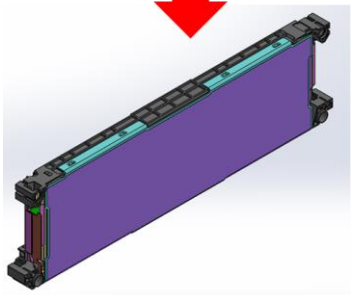


Case	Application location	Applied materials	Max. temp of cell CAN (℃)		Remark
			Bottom	Surface	
1	Default (Module : 6 pieces of cells)		43.0	71.0	Coolant: 25℃
2	**Inter-cells**	**Graphite Thermal Spreading Sheet**	43.0	65.0 (-6.0)	400W/m-K
3	**Module terminal height**	**Gap Pad**	43.0	64.5 (-6.5)	
4	**Upper Plastic Cover**	**Thermal Plastic**	43.0	63.0 (-8.0)	3W/m-K
5	**Module internal area**	**Liquid type of thermal interface material**	43.0	62.0 (-9.0)	0.3W/m-K
6	**Module/Cell dummy space**	**Immerse gap pad**	42.0	56.0 (-15.0)	

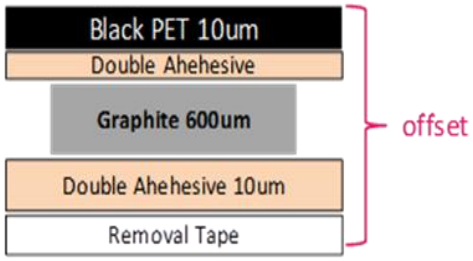
6.1 Battery Cartridge Thermal Solution



<Default Al-plate >

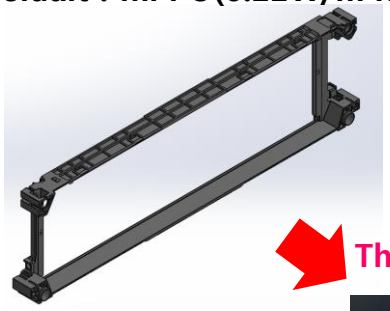


<Al + Graphite Heat spreader>

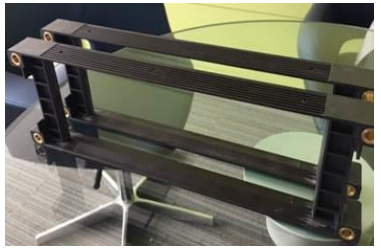


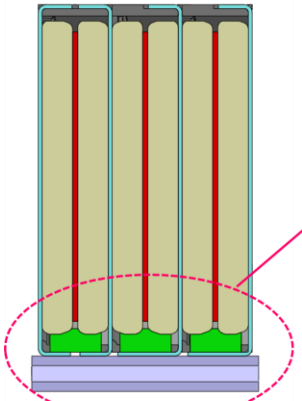
Prevent defects of Graphite layers separation by applying Offset structure

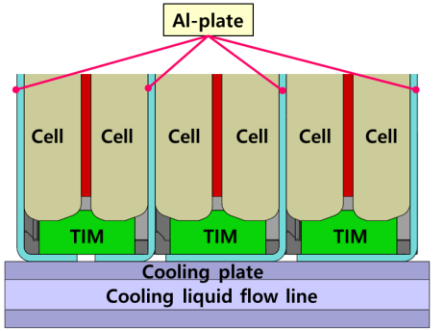
Default : mPPO(0.22W/m·K)

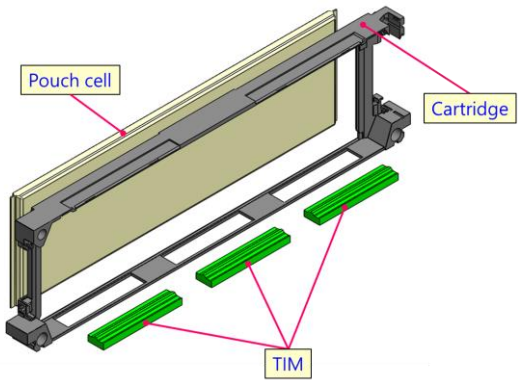


Thermal Plastic(3W/m·K)

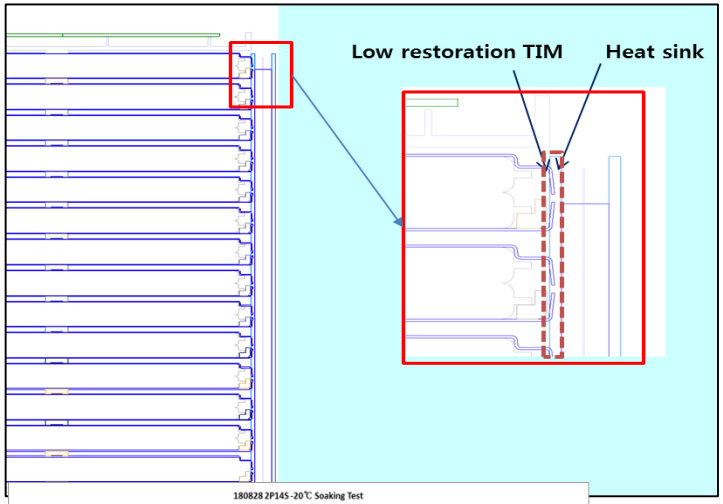


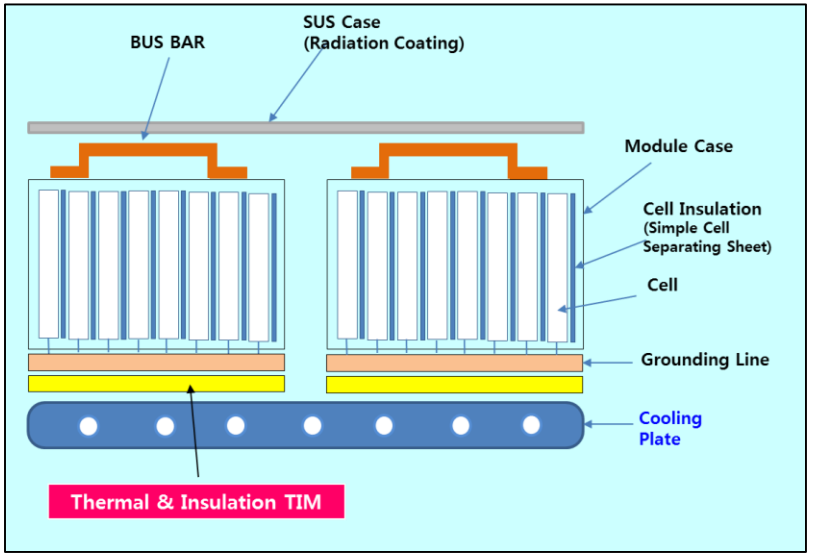


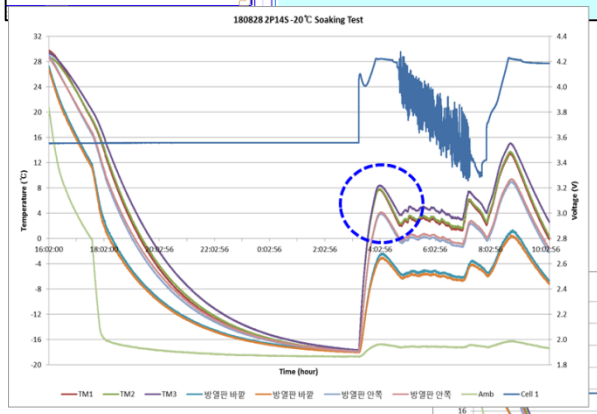




6.2 High Insulation TIM for EV Battery Cooling

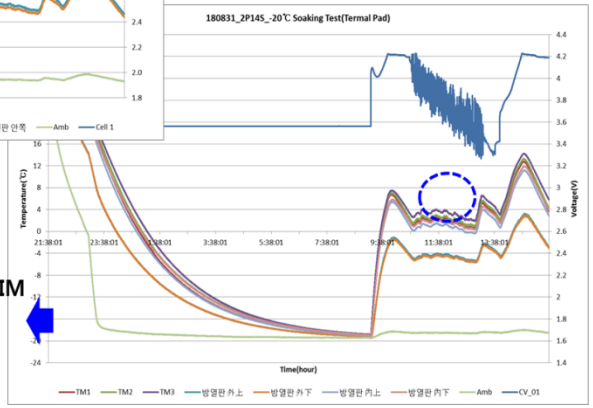






When TIM is not used

: Temperature deviastion 4~6℃



When applying low restoration TIM

: Temperature deviation 2℃

Under developing item 1

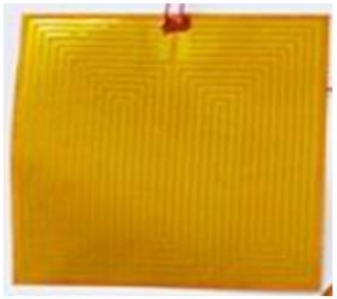
6.3 Battery pack heating and cooling & safety convergence

HTF + Thin Film Pressure Sensor + Temperature Sensor + Film Heater Integral Panel

▶ EV & ESS Performance Enhancement and Safety Management Purpose

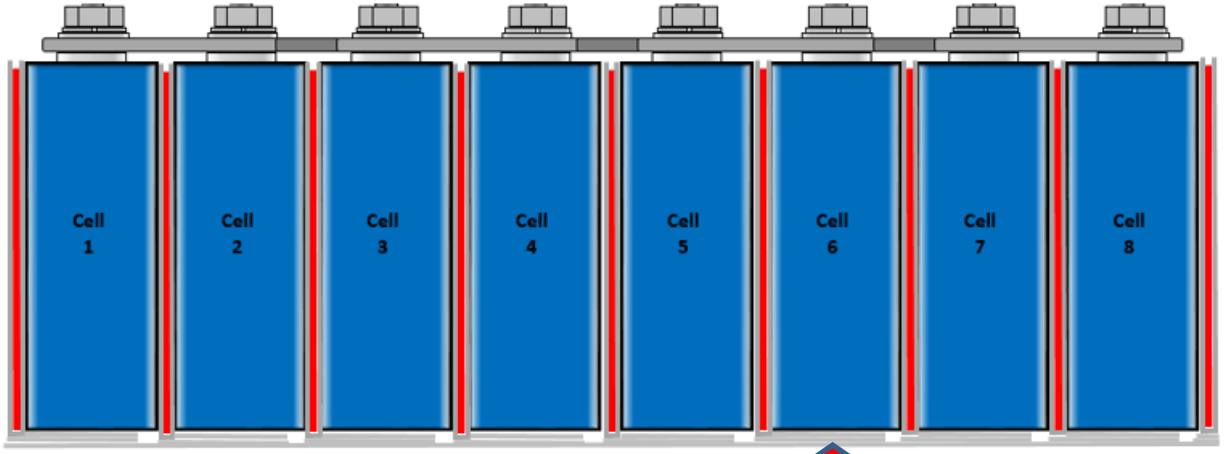
Thin Film Pressure Sensor

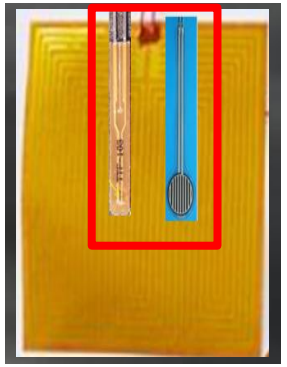
NTC Thin Film Thermistor



Film Heater

HTF : Hybrid Thermal Film)





HTF : Hybrid Thermal Film)

Film Heater+NTC Thermistor +Film Pressure Sensor

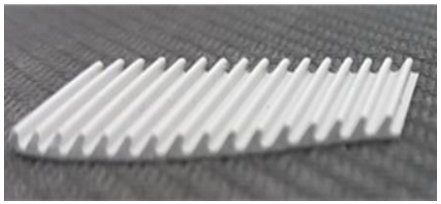
Plate Cooling & Heating

Under developing item 2

6.4 Battery Cooling Channel with TIM

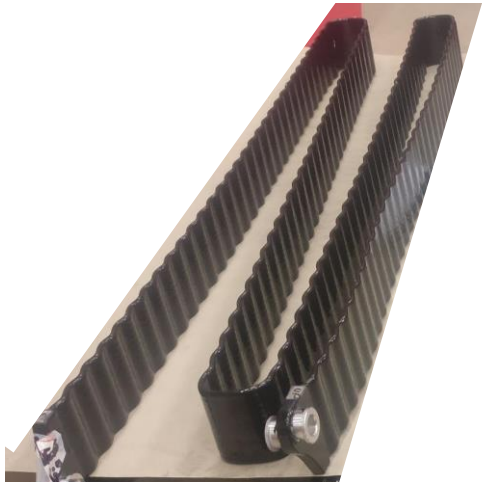
Insulation Pad

Teflon Tape

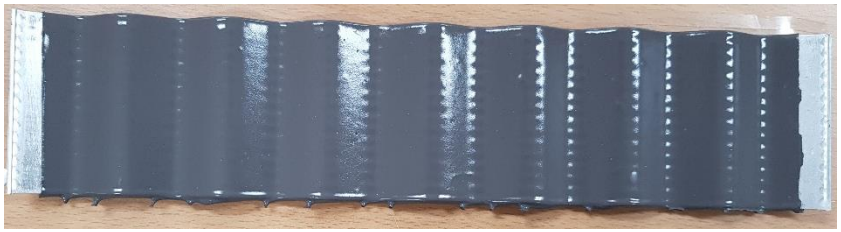


High Thermal Conduction & Insulation

1) Thermal Insulation Coating

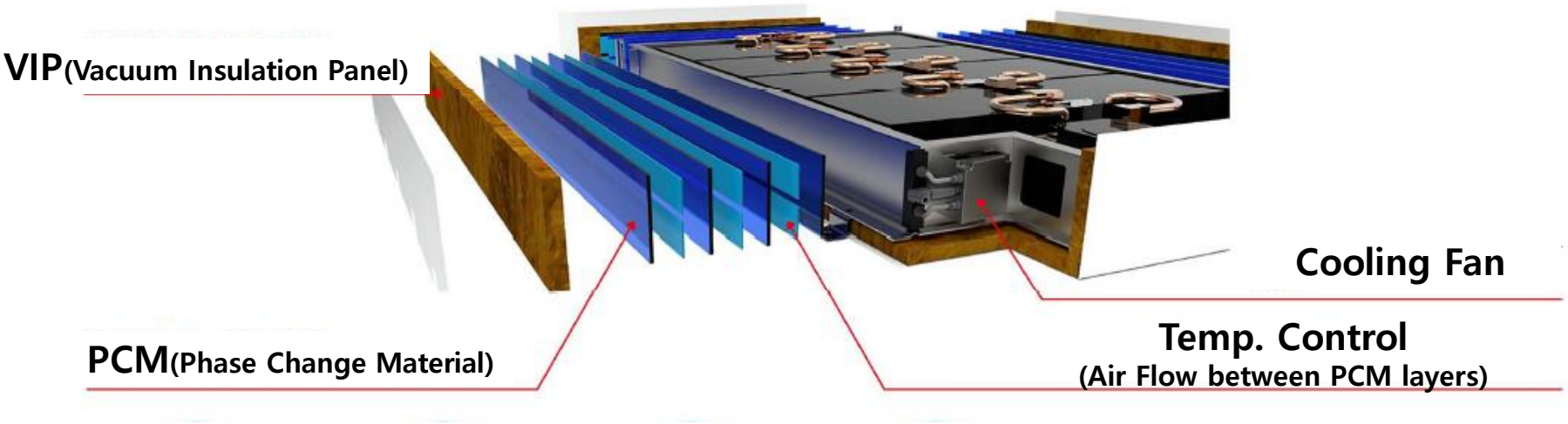


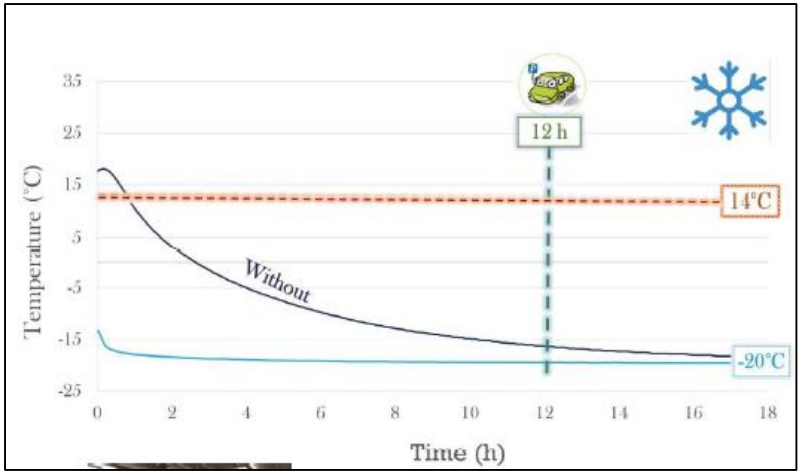
2) TIM(Thermal Interface Material) Coating

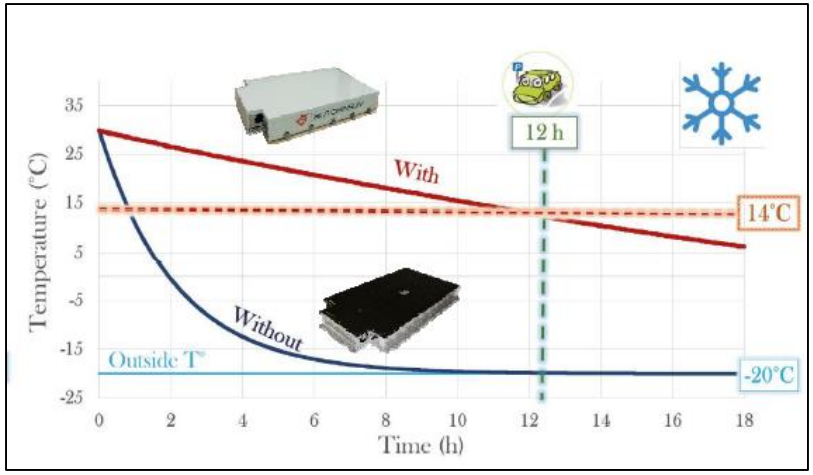


Under developing item

6.5 EV Battery Thermal Solution



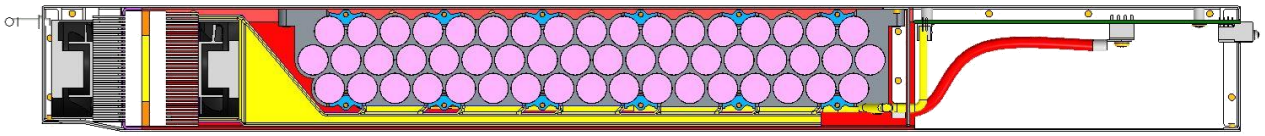




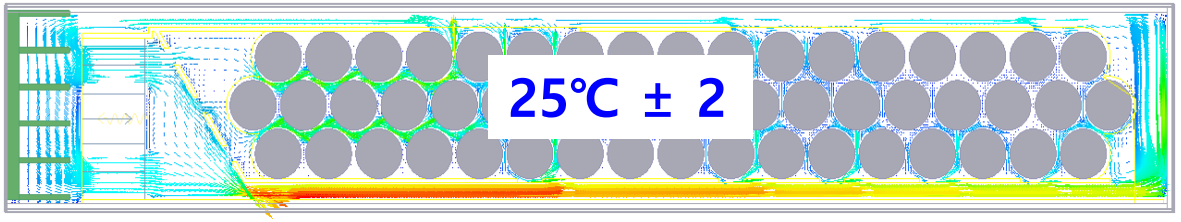
6.6 ESS Battery Module : Peltier Cooling System

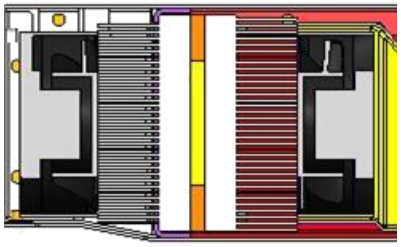
Core Technology

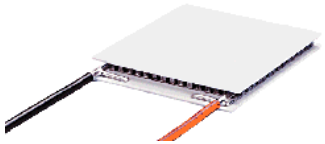
Peltier & Thermal Flow Design



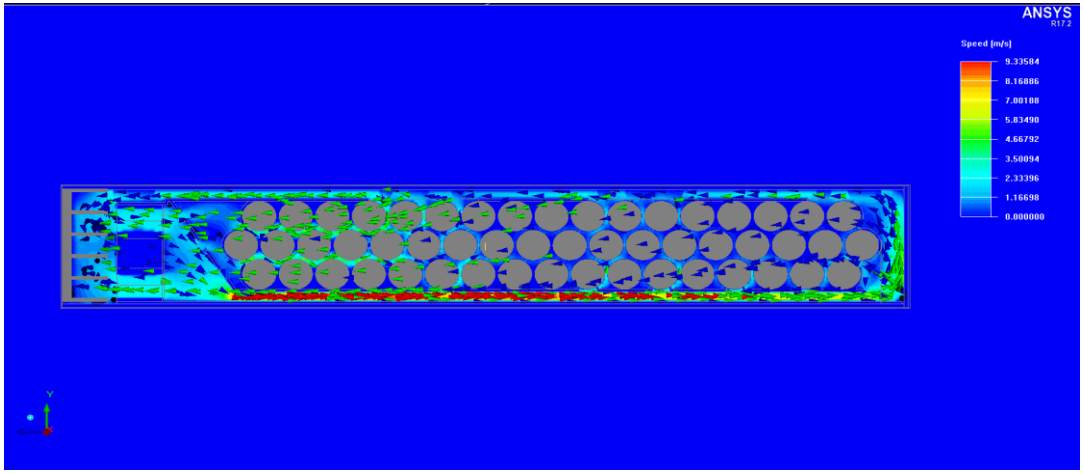
40℃ ↑



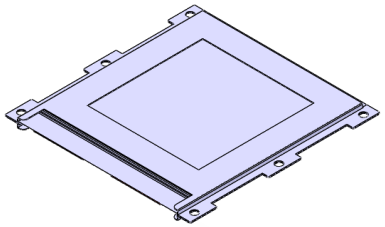


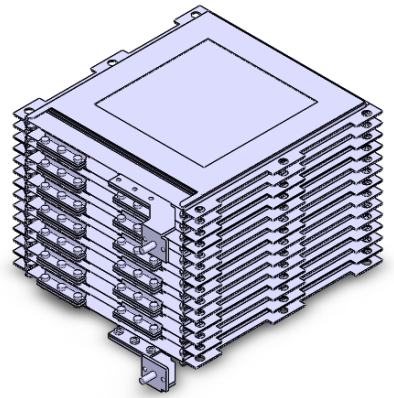


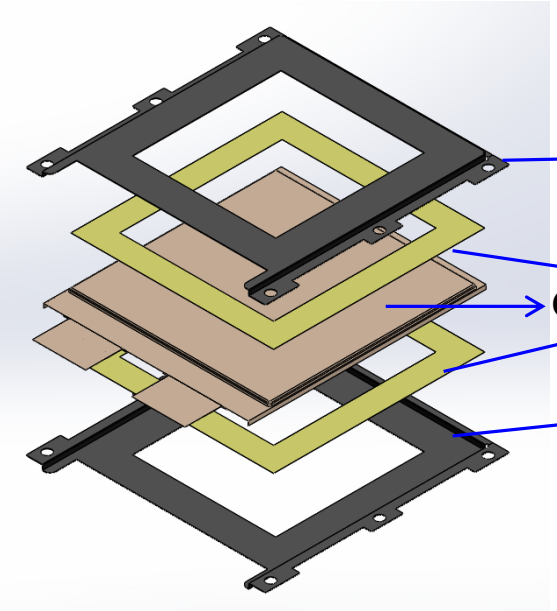
Peltier Cooling Module



6.7 Drone battery pack Thermal Solution



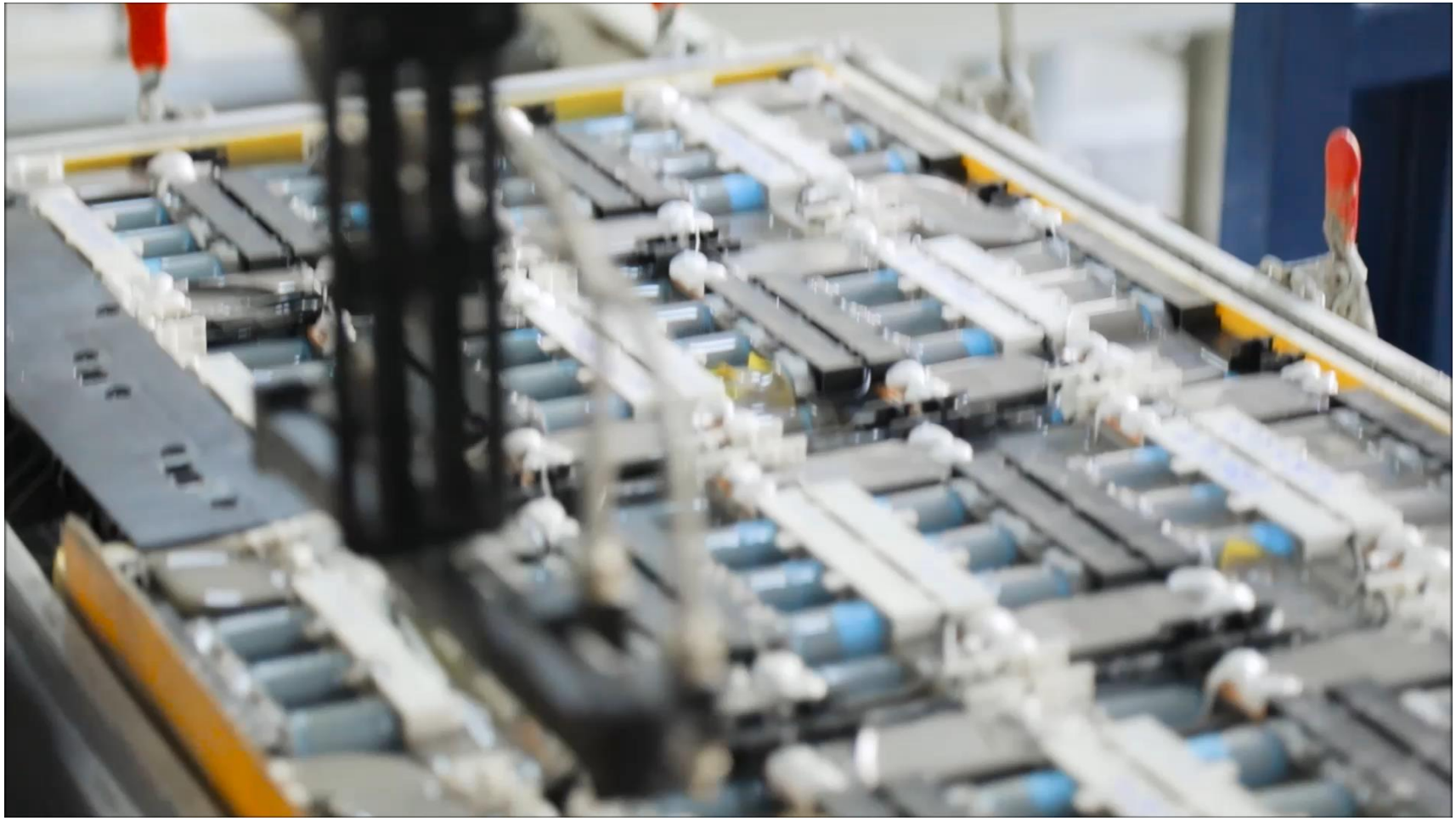




① Graphite(1500W/mK)-TIM : Thermal Heat spreading

② e-Coating : Thermal emission & electrical insulation

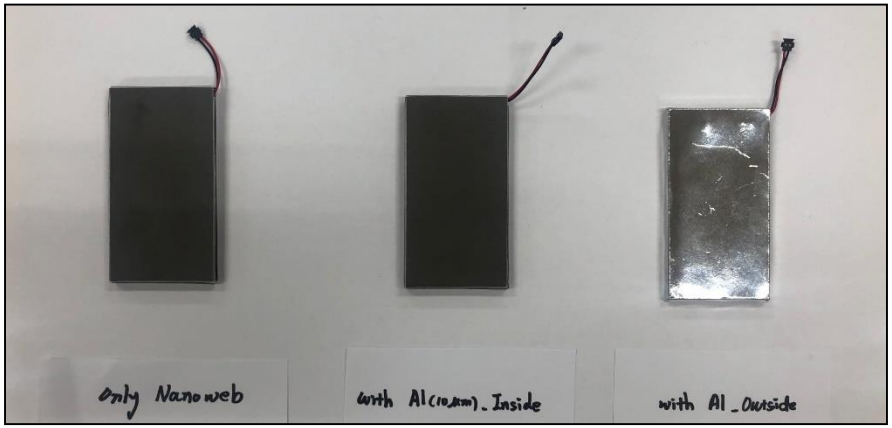
6.8 Liquid TIM For Battery Pack



6.9 IoT Battery Thermal Insulation

Battery Thermal Project for IoT device in Tokyo Olympics

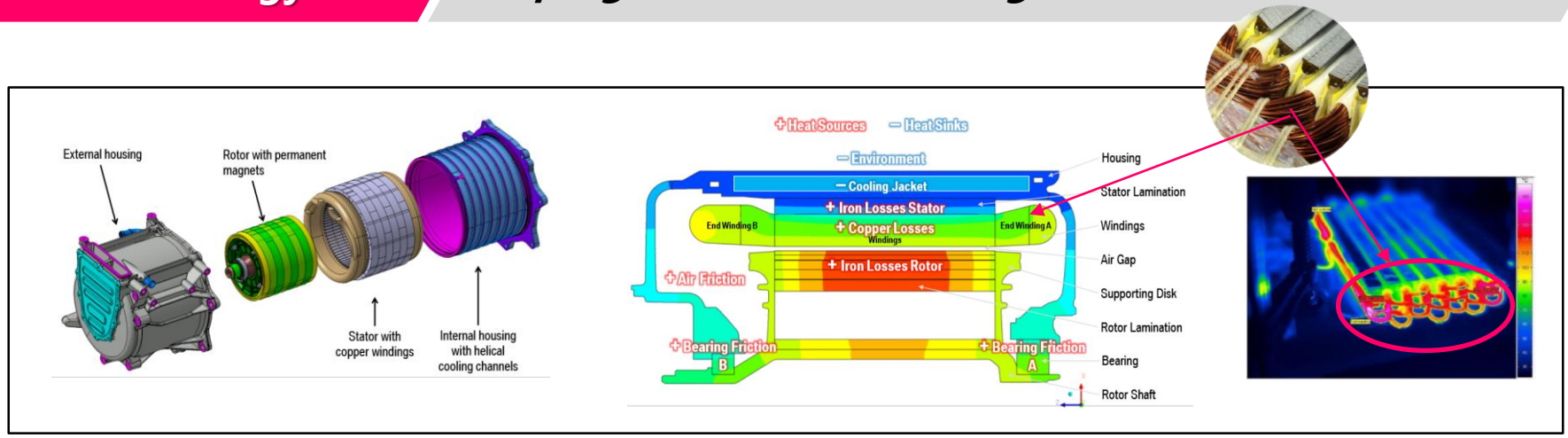
- Thickness : 100um ↓ insulation material applied.



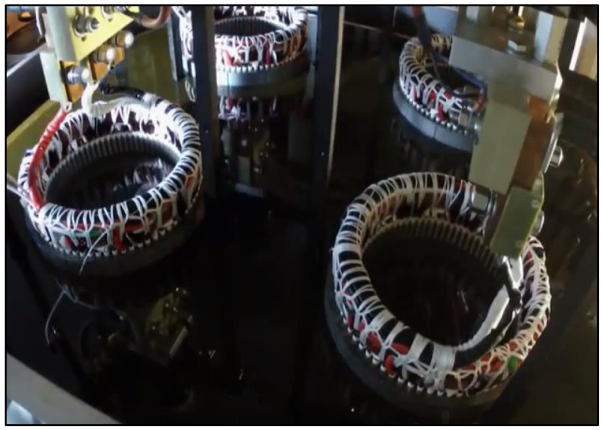
7. EV Motor Thermal Solution

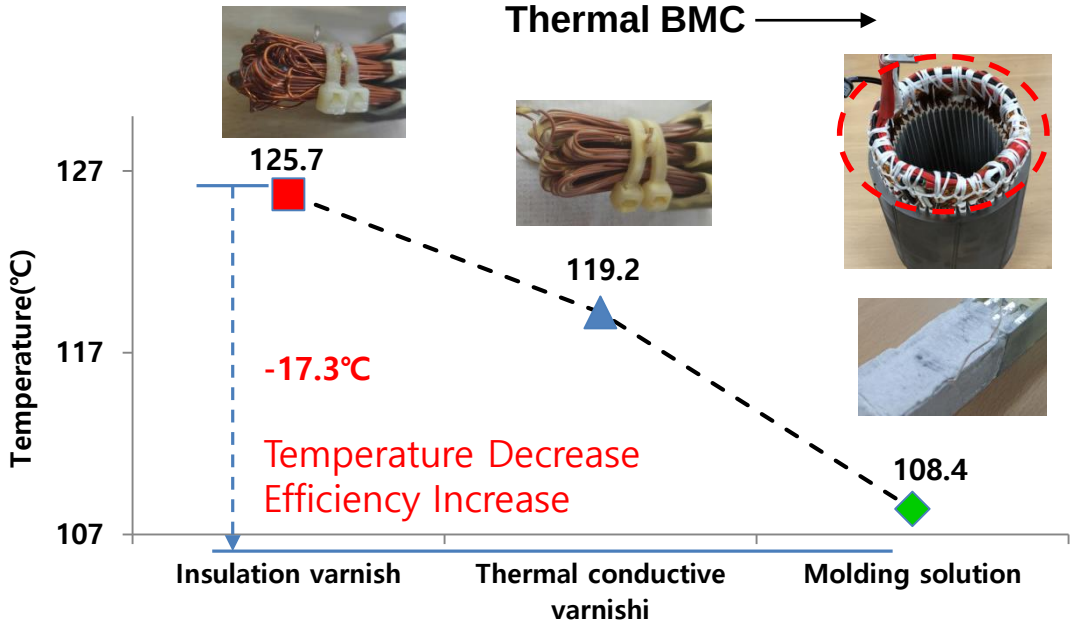
Core Technology

Impregnation and Molding in Stator Coil



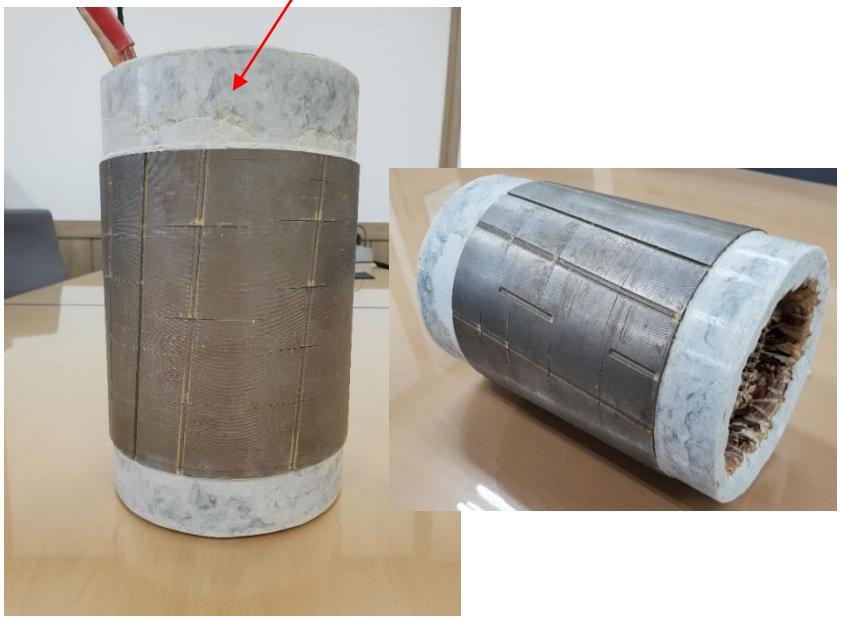
Impregnation thermal dissipation material in Coil

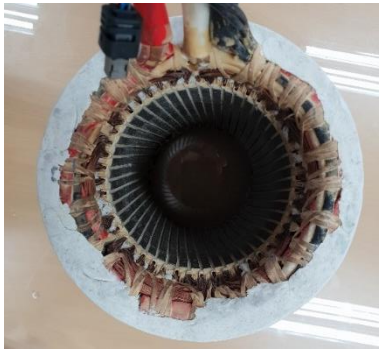




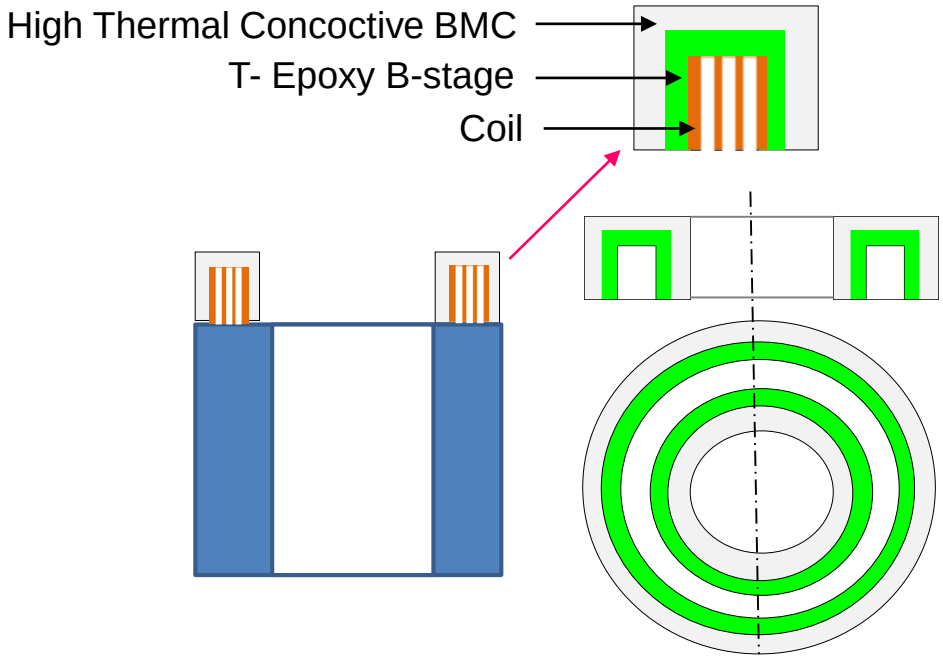
7.1 High Thermal Conduct Thermal BMC Molding

High Thermal Conductive BMC Molding





High Thermal Conductive BMC Cap



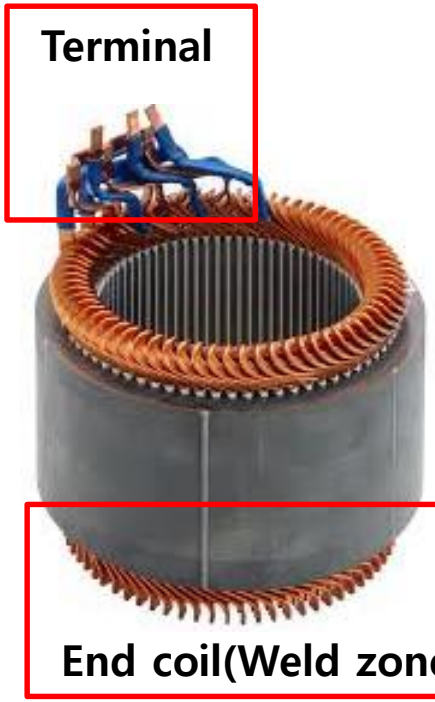
7.2 Thermal Insulation Cap for Hair-pin stator

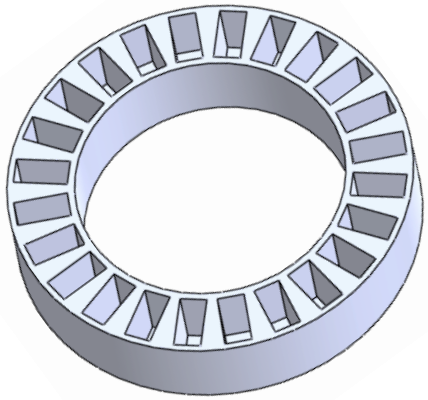
Thermal Insulation cover

Destroyed of Enamel insulated layers by welding

→ Difficult to apply powder coating due to the structure

→ Easy to assemble with Insulation cover





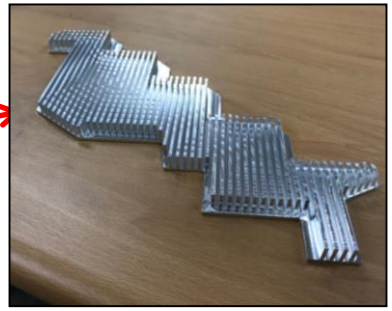
Thermal Insulation cap

- Relieve the heat from a terminal and an end coil
- Relieve the noise and vibration from a motor
- Prevent scratch in assembling with a rotor
- Good electrical, thermal characteristics & Available to apply flammability characteristics.

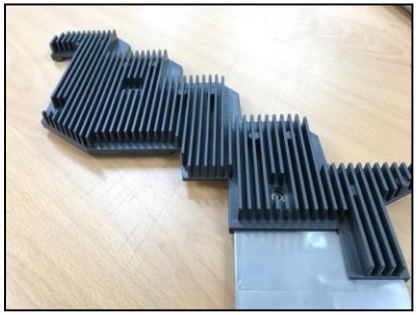
Thermal Insulation cap

10. Automotive lamp

1) Head lamp heat sink

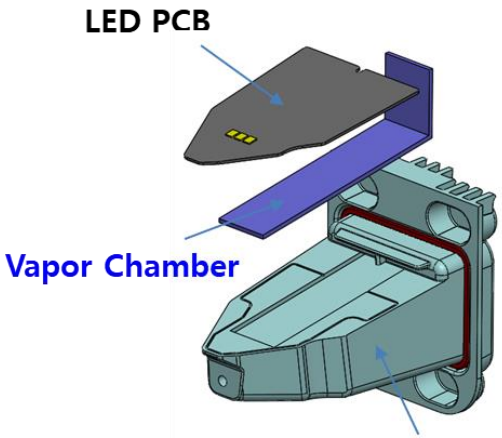


(Current) Al heat sink

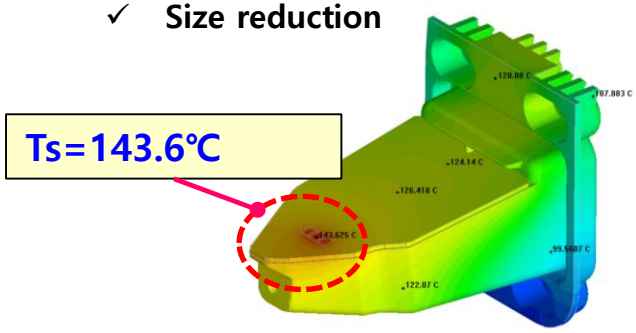


Thermal plastic heat sink(15W/mK)

2) DRL (Day Running Light)



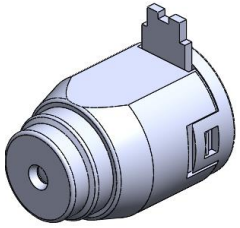
- ✓ Thermal plastic 15W/mK
- ✓ Vapor chamber
- ✓ Size reduction

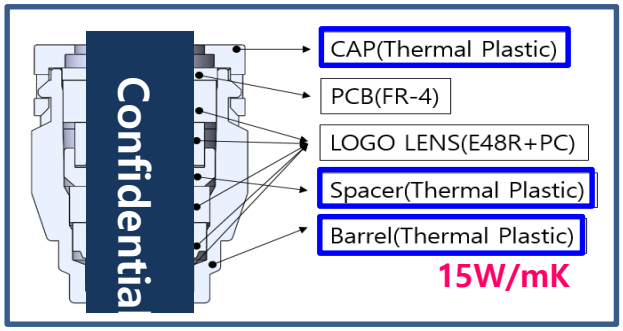


Temp. 21.3℃, Weight 22wt% improved

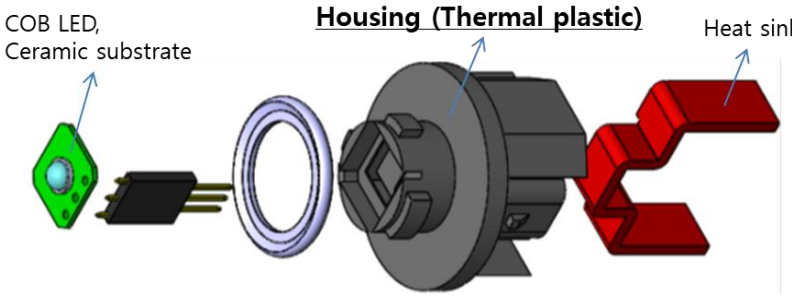
10.2 Door spot lamp

3) Door Spot Lamp

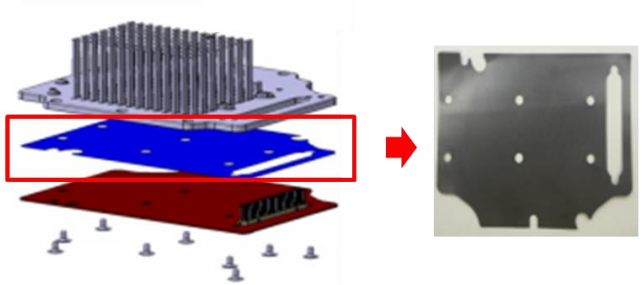




4) LED Tail lamp



5) Thermal foil for LED head lamp



AMO graphite TIM with excellent thermal conductivity between PCB and heat sink

Thank You

AMOGREENTECH
www.amogreentech.co.kr