8th edition

Smart PLASTICS

10|11 NOV 2021 MUSEO ALFA ROMEO ARESE

SFIDE E SOLUZIONI PER COMPONENTI DI VEICOLI ELETTRICI:

BATTERIE E COMPONENTI PIU' SICURI, EFFICIENTI E DURATURI

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Auto Electrification

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DuPont: Global premier multi-industrial

Mobility & Materials

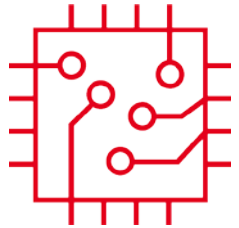
- Advanced Solutions
- Engineering Polymers
- Performance Resins

$4.0B

Water & Protection

- Safety Solutions
- Shelter Solutions
- Water Solutions

$5.0B



Electronics & Industrial

- Industrial Solutions
- Interconnect Solutions
- Semiconductor Technologies

$4.7B

$13.7B 2020 net sales	**23,000+** colleagues	**40+** countries	**~90** manufacturing sites	**10** major R&D centers

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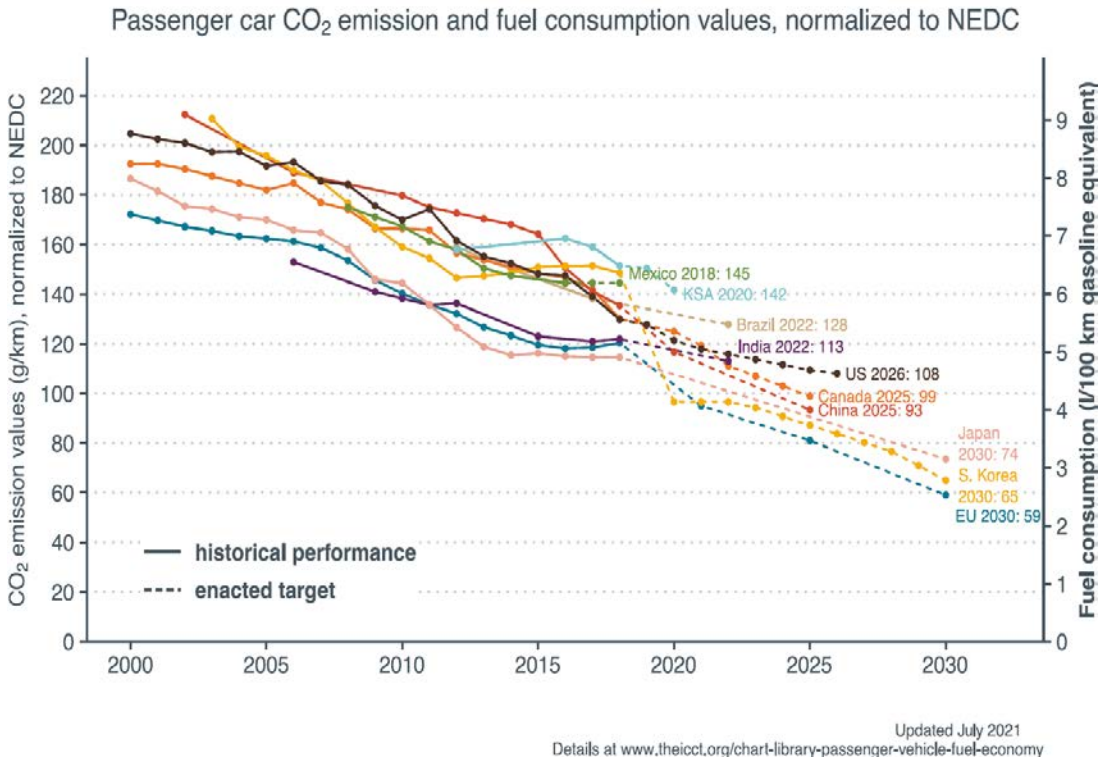
Auto electrification market

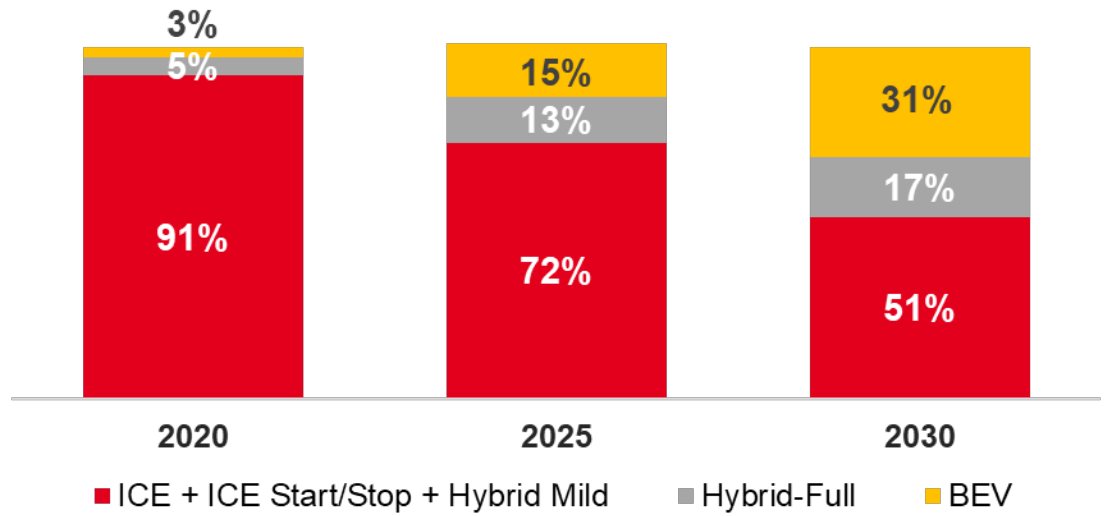
Global Passenger Car & Light Vehicles Emission Legislation 2000 - 2030



Cost Parity: EV & ICE

Regulatory, gov incentives, cost of battery decline

TCO, more consumer choices, infrastructure development



Sources: IHS analysis

Component and materials Challenges

Component requirements

High (charging) power & high energy batteries

New fluids

Integration of components

High power, high torque
compact electric motors (15-200 kW)

High voltage
up to 1kV, up to 3kV testing voltage

Material requirements

- Electrical properties (e.g. breakdown voltage, Comparative Tracking Index)
- UL listing, flame retardancy, non-halogen
- Distinctive colour (orange)

- Temperature requirements (EIS classes, RTI-Relative Thermal Index, CUT)
- Chemical resistance (coolants, dielectric fluids, ATF)

- Good adhesion to metal (overmolding) and low CLTE
- Thermal conductivity
- Electrical conductivity (EMI-shielding)

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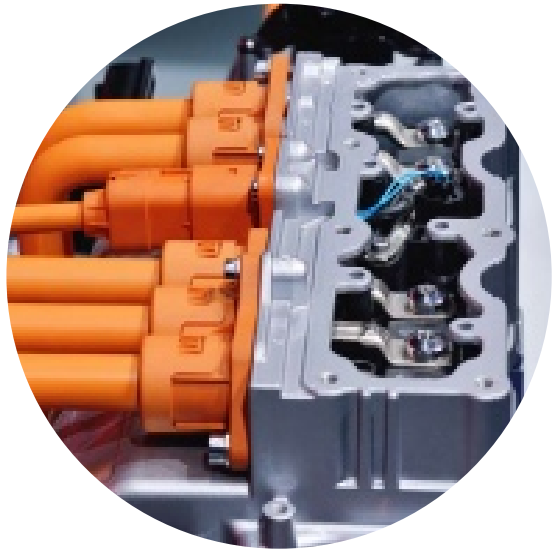
Improving Durability of High Voltage Components

APPLICATIONS

- HV connectors & busbars
- HV relays & switches

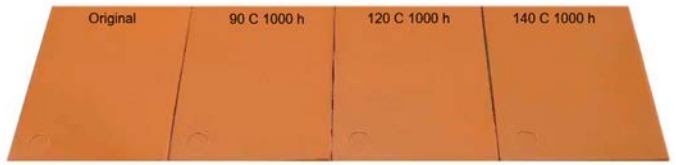


REQUIREMENTS

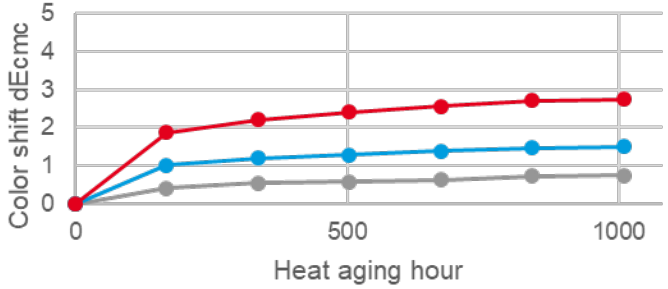
- Orange color stability for high voltage part identification over time and temperature
- Constant electrical properties over time and temperature, hydrolysis resistant
- Resistant to heat shocks and adhesion to conductors
- High comparative tracking index and non-halogen flame retardant formulations

SOLUTIONS

Crastin® PBT FR Non Halogen , Zytel ® PA 66 FR Non Halogen



Crastin® FR684NH1 OR168



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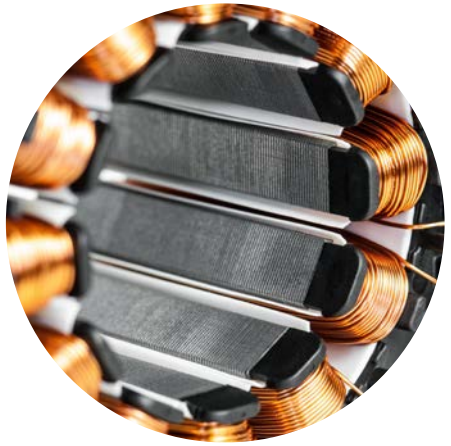
Preventing Electrolytic Corrosion of Insulation Parts

APPLICATIONS

- HV & LV connectors & busbars
- Sensors, relays & switches

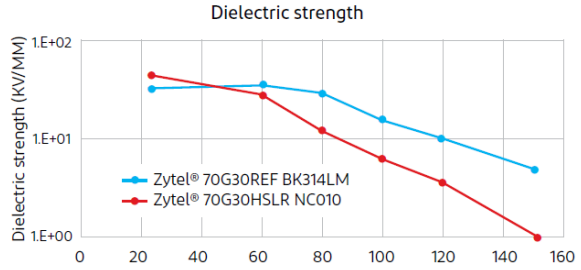


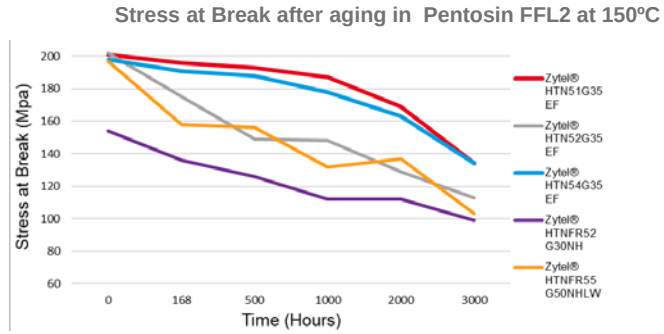
REQUIREMENTS

- Resistance in harsh environment: high voltage, humidity and temperature up to 180°C
- Low halide containing materials that extend component lifetime
- Laser-markable formulations that allow for part identification through QR and DMC codes
- Durability & Compatibility (ATF and e-motor immersion cooling fluids up to 150°C)

SOLUTIONS

Polyammide Electrically Friendly Portfolio
Zytel PA66, Long Chain, HTN





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Improving Durability of Seals & Gaskets

APPLICATIONS

- HV connectors sealings
- Power electronics and Battery sealings
- Transmission sealings

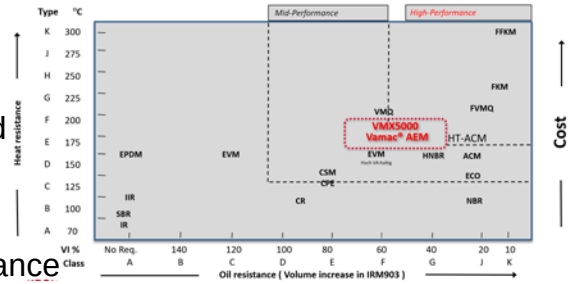
REQUIREMENTS

- Low compression set for durable sealing
- Compatible with ATF and e-motor immersion cooling fluids up to 150°C
- Compatible with battery immersion cooling fluids up to 100°C
- Compatible with flame-retardant non-halogen materials

SOLUTIONS

Vamac® (AEM) amorphous ethylene / acrylic elastomer copolymer

- (A) Polar acrylic monomer responsible for good oil and lubricant resistance
- (E) Ethylene provides low temperature properties, responsible for good water- and acid-resistance
- (M) Saturated polymer chain for excellent thermal stability



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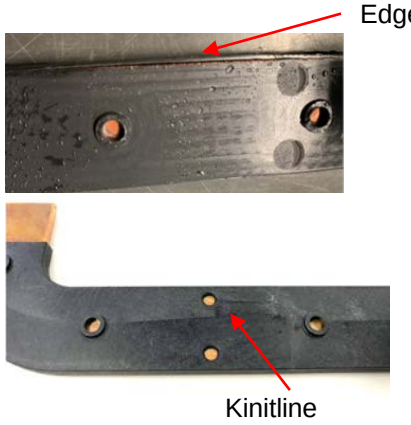
Improving thermal shock resistance for Motor and Power Electronics



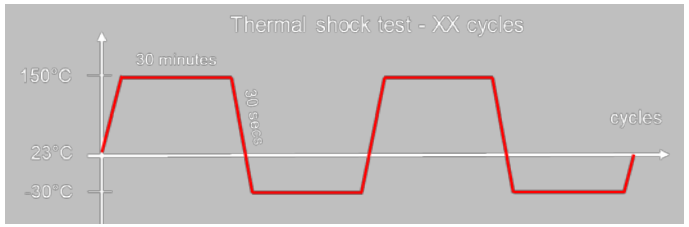
Issue

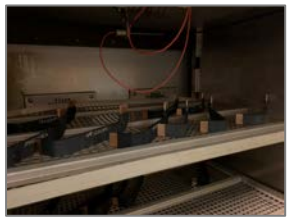
- Bus bars: conductors for electric system (multi or single phase overmolded)
- Unwanted cracks during life time (typical cycles: -40/-30°C to 150°C up to 1000 hrs
- Conditions becoming more critical with contact with dielectric oils and ATF

Approach

- Application testing vs material testing
- Manufacturing of critical prototype and thermal chamber testing

Multiple gating scenarios
Over-molded copper insert
with different thicknesses: 1 to 3 mm





Improving thermal shock resistance for Motor and PE

Results

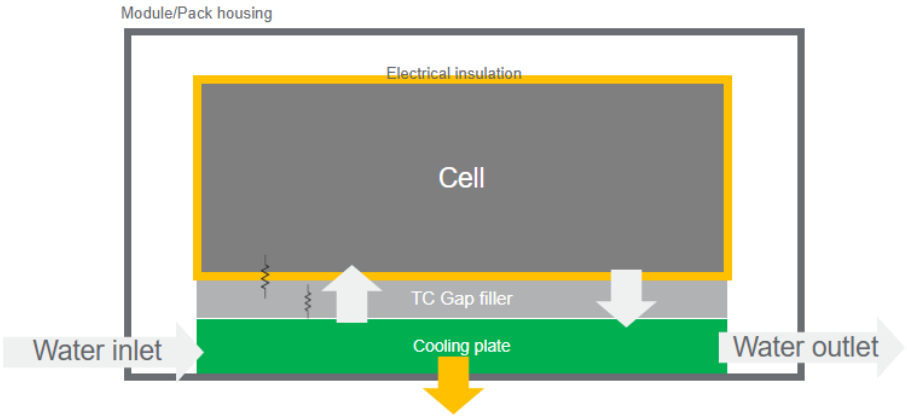
- Specific Zytel HTN designed passing requirements
- Better than PPS impact modified grades

Grade	72h	96h	168h	240h	336h	384h	432h	480h	540h	630h	702h	846h	990h	1200h	Failure mode
PA66 30%GF FR	0	0	0	2	2	3	.	.	.	.	.	.	.	-	knitline
Zytel HTN FR55G50NHLW - PPA 50GF% FR	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
PA66 30%GF	0	0	0	0	0	0	0	0	0	0	0	1	1	3	knitline
Zytel HTN 55G55TLW - PPA 50GF%	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Zytel HTN FR52G30NH -PPA 30GF% FR	0	3	.	.	.	.	.	.	.	.	.	.	.	-	knitline
HTN 54G35EF BK420- PPA 35GF%	0	0	0	0	0	0	0	0	0	0	0	0	1	3	knitline
PPS 40%GF	0	0	0	3	.	.	.	.	.	.	.	.	.	-	edge crack
PPS 50% GFMineral	0	2	2	3	.	.	.	.	.	.	.	.	.	-	edge crack
PPS 50% GFMineral IM	0	0	0	0	0	0	0	0	0	0	0	0	1	1	knitline

Key variables

- Dimensional stability, CLTE
- Elongation at break, weldline strength and rigidity
- Type of fillers and type of PPA copolymer
- Metals type, Design & processing recommendations

Improving thermal thermal management for batteries



Issue

Unwanted heat dissipation through housing

→ Loss of heating performance

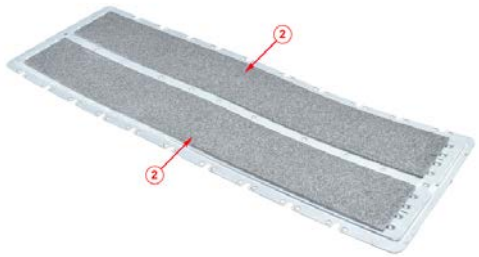
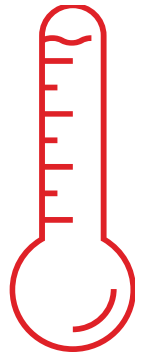


Photo courtesy of A2Mac1

Current market solution example

Hyundai Kona – 10mm EPP foam between the bottom plate & casing

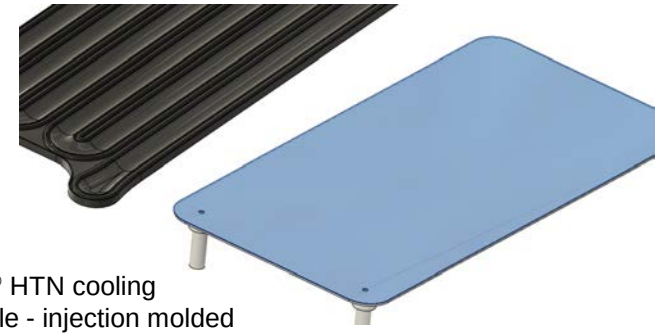


At <0°C, discharge power is reduced and charge capability disappears

Reduced range below 15°C

Ideal temperature range is actually quite narrow: 20°C~40°C

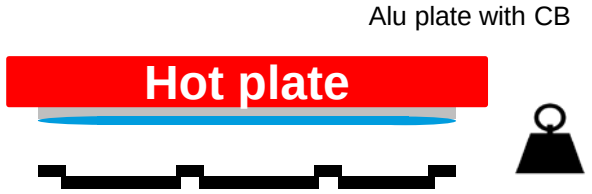
Hybrid cooling plate concept

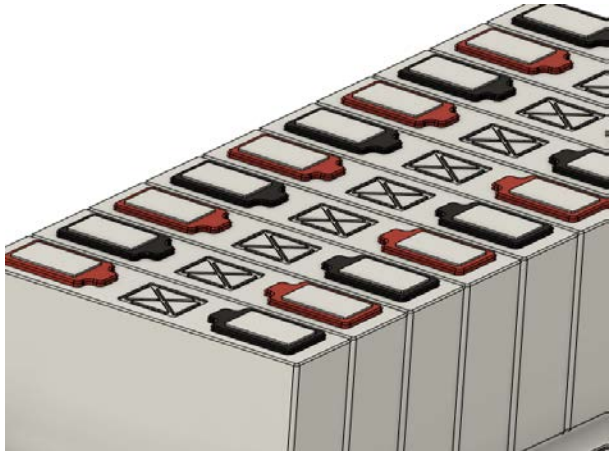


Zytel® HTN cooling module - injection molded

Aluminum plate with DuPont chemical bonding CB solution sprayed on the bottom surface

Plastic – metal bonding activated via hot plate welding





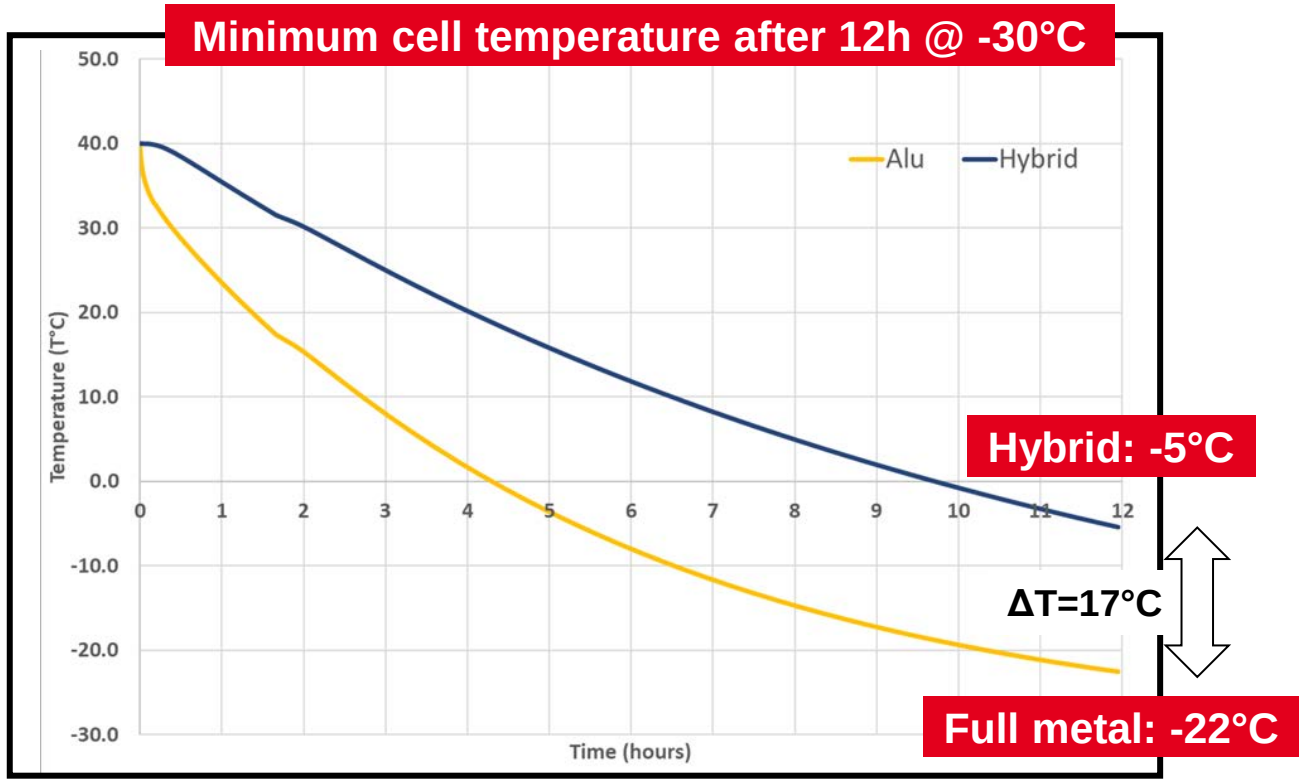
1. Prepare Samples

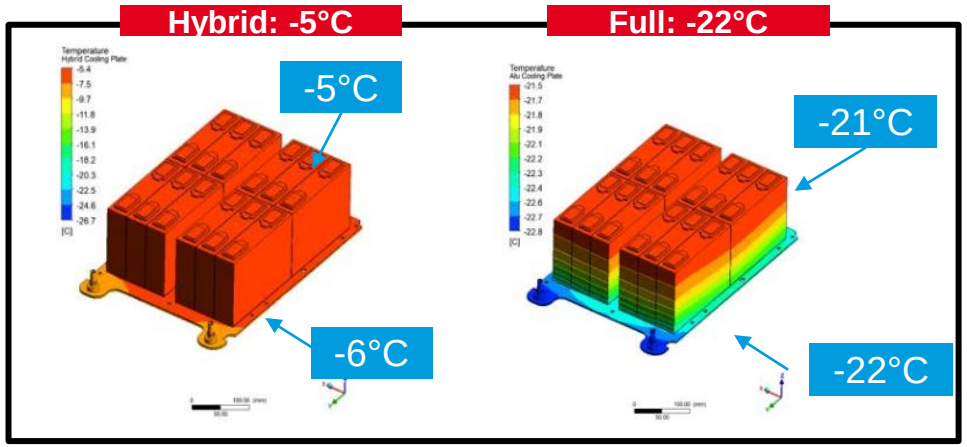
2. Assemble Cooling Module

3. Assemble Cells

How much difference in heat retention

Vehicle parked overnight at -30°C – no fluid flowing through the channels
Hybrid solution allows the cells to stay warmer





- Cycle time vs. brazing and Energy cost reduction for assembly
- Improvement in coolant turbulence from design flexibility of plastic
- Improvement in durability & performance of the cells
- Functions integration

Conclusions

- Evolution of specifications from OEMs in Auto Electrification area means new material developments and new properties will require investigation
- DuPont Mobility& Materials supports customers with the development of new concepts and application re-design with:
  - CAE
  - Processing capabilities
  - Prototyping
  - Application testing capabilities
  - The Auto Electrification Center of Excellence