



**PCC™**

Thermal Runaway and  
Thermal Management Cell Holder

Prevent thermal runaway propagation  
by absorbing and distributing heat  
quickly

+ Specifications	Unit	Detail	PCC37-1000	PCC48-1000	PCC55-1000
<b>Melting Point</b>	°C		37	48	55
<b>Melting Range</b>	°C		32 – 38	45 – 50	48 – 57
<b>Density</b>	(kg/m <sup>3</sup> )	Room Temperature	895	890	875
<b>Thermal Expansion - Solid Phase</b>	(%/°C)	Measured from room temperature to melting onset	0.100	0.074	0.146
<b>Thermal Expansion during Melting</b>	(%/°C)	Measured during melting	0.841	0.839	0.494
<b>Thermal Expansion - Liquid Phase</b>	(%/°C)	Measured after melting to 75°C	0.075	0.051	0.075
<b>Thermal Conductivity</b>	(W/m*K)	XY-plane	10 – 25	10 – 25	10 – 25
		Z-plane	6 – 12	6 – 12	6 – 12
<b>Latent Heat</b>	(J/g)		155	180	150
<b>Specific Heat</b>	(J/g°C)	Specific Heat-Solid	1.91	1.82	1.96
		Specific Heat-Liquid	2.25	1.96	2.20
<b>Electrical Resistance</b>	(10 <sup>-3</sup> Ωm)	XY-plane	0.41	0.33	0.37
		Z-plane	0.19	0.14	0.16
<b>Thermal Cycle Life</b>		# of melting cycles	>10,000	>10,000	>10,000

+ Operational Benefits

- Can stop propagation of thermal runaway
- Absorbs rapid thermal fluxes
- Protects cells from hot environmental conditions
- Maintains consistent temperature across pack at all times
- Acts as primary cell holder

+ Design Features

- Simple and passive, requires no moving parts or power
- Less expensive and bulky than active thermal management systems
- Can complement active cooling systems
- Wide range of melting points and latent heat

+ Certifications

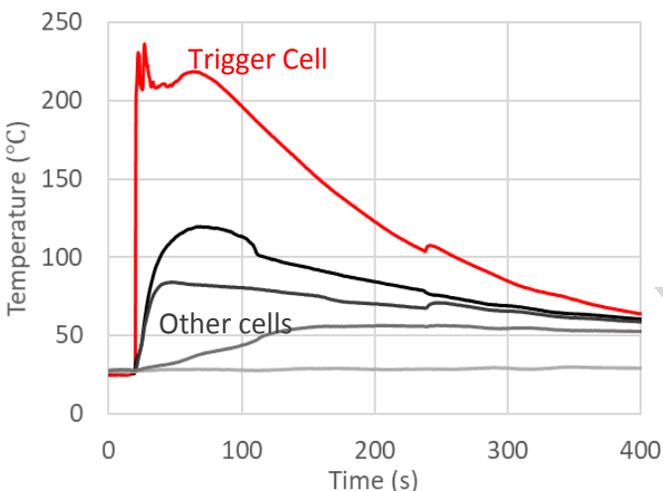
- AllCell's PCC has passed the UL 94 V-0 Flammability test



# Phase Change Composite (PCC™)

*Heat is a battery's greatest enemy. Batteries generate heat when they discharge electricity and are often placed in hot environments or in direct sunlight. Regardless of the source of the heat or the specific battery chemistry, when batteries get too hot, three bad things can happen: thermal runaway, cycle life decreases, and battery performance decreases. AllCell has developed a solution to the battery thermal management challenge that is simple, lightweight, low cost, and passive. AllCell's PCC™ has no moving parts and requires no energy to operate, yet provides effective protection against overheating and thermal runaway while significantly extending cycle life.*

215 Wh/kg Module Nail Test with PCC



## + Prevent Thermal Runaway Propagation

Thermal runaway is a technical term for a rapid uncontrolled increase in temperature. In lithium-ion cells, thermal runaway can be triggered by internal short circuits, physical damage, or overheating of the cell. For batteries, the key safety concern is thermal runaway propagation - a chain reaction that spreads to the surrounding cells that can lead to serious fires or large explosions. Simulation results, field tests, and 3<sup>rd</sup> party evaluations show AllCell's PCC technology successfully prevents thermal runaway propagation.

## + Increase Life Cycle

The result of limiting maximum temperature and ensuring temperature uniformity is a dramatic increase in cycle life. The graph to the left illustrates the typical increase in cycle life driven by adding PCC to a battery pack. If the battery pack in this example cost \$250, the capital cost per charging cycle would be reduced from \$0.63 to \$0.35.

## + Limit Maximum Temperature

In the same way that an ice cube keeps a glass of water at 32°F, AllCell's PCC™ composite limits the maximum temperature of the battery pack to the melting point of the phase change material within the PCC™ throughout absorbing heat by melting. The phase change material—typically a wax—is encapsulated within graphite to remain shape stable.

## + Maintain Temperature Uniformity

AllCell's PCC™ material also ensures temperature uniformity across cells in each battery pack. As each cell discharges electricity and begins to heat up, the graphite within the PCC™ distributes the heat evenly throughout the pack, avoiding hot spots and keeping the temperature of the hottest cell no more than 3°-5°C higher than the coldest cell.

1C discharge of 265 Wh/kg cell

