

Need for Intervention

Challenges involved with Li-ion batteries in EV's

Lithium-ion batteries are widely used in Electric 2, 3 and 4-wheeler vehicles with varied power capacities ranging from 1 kWh – 5 kWh for 2-wheelers and more than 5kWh for 3-wheelers. Since the electrochemistry of Li-Ion batteries is *temperature sensitive*, allowing batteries temperatures to go beyond the tolerance envelope can result in a multitude of issues such as;

1. Increase in reaction kinetics leading to uncontrolled exothermic reactions within the battery.
2. Moderate overcharging can lead to high temperatures ultimately causing short circuit.
3. Reduction in the life of the battery pack if allowed to be exposed constantly at high temperatures < 45 deg C during lifetime.

Battery type	Charge temperature	Discharge temperature	Charge advisory
Lead acid	-20°C to 50°C (-4°F to 122°F)	-20°C to 50°C (-4°F to 122°F)	Charge at 0.3C or less below freezing. Lower V-threshold by 3mV/°C when hot.
NiCd, NiMH	0°C to 45°C (32°F to 113°F)	-20°C to 65°C (-4°F to 149°F)	Charge at 0.1C between -18°C and 0°C. Charge at 0.3C between 0°C and 5°C. Charge acceptance at 45°C is 70%. Charge acceptance at 60°C is 45%.
Li-ion	0°C to 45°C (32°F to 113°F)	-20°C to 60°C (-4°F to 140°F)	No charge permitted below freezing. Good charge/discharge performance at higher temperature but shorter life.

Technology & Solution Overview

Phase Change Materials (PCMs) are advanced thermal energy storage materials that act as **thermal batteries**. PCMs offers the ability to absorb and store heat dissipated by the batteries at a designed temperature eg. 45 deg C in the absence of which the battery temperature is allowed to go beyond the threshold limit. The PCM self regenerates when the ambient temperature cools down, without requiring any external source of energy or refrigeration. Pluss has developed several PCMs suitable to the application of thermal management of Li-ion batteries. Pluss also supports in customization of offered solution such as the designed temperature, form factor and method of integration could vary based on the battery back design and manufacturers preference. The range of designed temperature of PCM's commonly sought is between 35°C to 50°C.

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Key Benefits of passive thermal management through PCMs: -

1. High latent heat capacity of PCM provides for efficient heat storage density.
2. Prolonged temperature control within threshold limits during battery pack operation.
3. Electrically non-conductive with low dielectric constant.
4. No degradation in latent heat with high rate of cycling.
5. High thermal conductivity enabling an optimum balance of heat absorption and dissipation.
6. Cost-effective compared to mechanical forced cooling or liquid cooling.

Impact / Value addition for the bike:-

1. **Improved range** – By increased useable capacity of the batteries by 25%
2. **Safety** – Reduces the instance of a thermal runaway occurring by 4 times. On prolonged exposure to fire PCM based battery pack delays the chain reaction by 40 minutes as compared to 5 to 10 minutes without PCMs.
3. **Faster charging** – Enables enhanced charging performance.

Solutions Overview

1. Flood and Fill Method

The Flood and Fill method is the simplest form of application of PCM to a battery pack. The PCM is filled in the battery pack casing and the entire pack is immersed in the PCM making perfect contact with the cells.

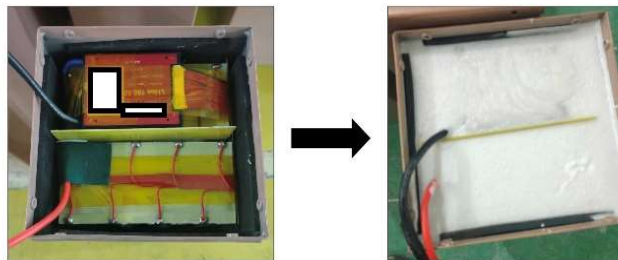


Fig.1 Flood and Fill system with PCM save[®] OM42

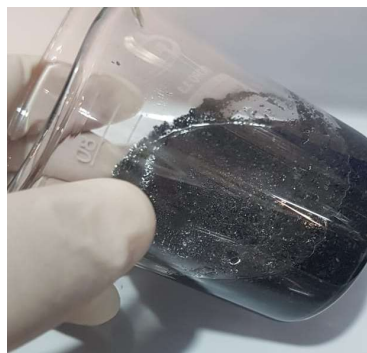


Fig.2 Flood and Fill system with high thermal conductivity PCM save[®] OM42

2. Form-stable PCM technology

The Form-stable PCM block is a high thermal conductivity polymer matrix containing Phase Change Material that stays in a consistent shape while exhibiting properties of PCM with high latent heat and temperature control. It offers flame retardant properties, high

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mechanical strength for impact resistance and is accommodating for your battery pack design giving superior performance even in high ambient temperature regions.



Fig.2 Form-stable PCM block

About PLUSS[®]

PLUSS[®] is a materials research and manufacturing company in the field of Phase Change Materials (PCMs) for **thermal energy storage**. PLUSS pioneered PCM based Sustainable Temperature Control Solutions across sectors including refrigeration, food and pharmaceutical cold-chain, medical devices, building HVAC, agriculture, electric vehicles, etc. Experience, interdisciplinary thinking, and practical skills form the growth guidelines of PLUSS[®] and has helped it receive various recognitions by Government and Industry bodies. PLUSS[®] contributes significantly towards innovative solutions that create a definitive change in the thermal energy storage industry and developing breakthrough products to meet the current and future needs of the society. Research and Innovation has been the cornerstone of the company since its inception. With a network of partners world over and offices in **India and Europe**, PLUSS is today well poised to make a global impact with its innovative solutions.

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