

ENERGY STORAGE SYSTEMS

Battery Thermal Management Solution

Low-temperature pre-heating for energy storage battery packs using CNT flexible heating film.

- Pack pre-heated to working temperature within 10 minutes
- 1-2 mm flexible jacket — no loss of pack volume
- Dual-sensor control integrated with the existing BMS

FlexTherm · Shanghai Burning New Material Co., Ltd.

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01 CORE MATERIAL

Carbon Nanotube Heating Film

CNT heating film is a self-assembled network structure formed from freely arranged carbon nanotube arrays. It combines excellent mechanical, electrical and thermal performance with high chemical stability, and is one of the most promising energy-saving heating materials available for industrial adoption today.

99.5%**Electro-thermal conversion**

Electrical energy converted into usable heat

1.35 g/cm³**Ultra-low film density**

Average film thickness of only 5 μm

3500 W/m·K**Thermal conductivity**

Very low heat capacity: instant on, instant off

0.89**Normal total emissivity**

Strong far-infrared radiation characteristics

60%+**Thermal radiation ratio**

Higher usable heat output per watt

±1 °C**Temperature accuracy**

NTC sensing plus proprietary control algorithm

Surface heating, not line heating

Conventional resistance wire heats along a line, producing hot spots and cold gaps. CNT film heats across its entire surface, so heat distribution is even, controllable and repeatable across large or irregular areas.

02 SYSTEM ARCHITECTURE

CNT Flexible Thermal Management System

Encapsulation fabric > CNT heating film > FPC circuit > NTC sensor > Encapsulation fabric

Ultra-thin and fully flexible The extremely high aspect ratio of carbon nanotubes forms a self-assembling film network. It can be bent, folded and crumpled freely, solving the poor flexibility and poor surface contact of conventional heating pads.	Fast, even heating Surface temperature rises to the set point within seconds. The film emits far-infrared radiation in the 6–14 μm band, which penetrates directly into the target medium rather than only warming its surface.
Safe by design Powered from 3.7 V / 5 V / 7.4 V / 12 V / 24 V low-voltage inputs, far below the 36 V human safety limit. Multi-layer protection covers over-current, short circuit and open circuit.	Intelligent temperature control In-house hardware and control-algorithm development enables multi-level precision control, with heating profiles tuned to each customer's temperature and timing requirements.
Machine washable The film's resistance to repeated folding supports 40 standard wash cycles. FlexTherm heating assemblies carry a high waterproof rating and retain full performance after washing.	Instant heat-up, precise holding Sheet resistance is very low and extremely uniform, so heat-up is immediate at minimal power draw. Patch NTC sensors bonded to the film deliver ± 1 °C control accuracy.

Verified heat-up curve

With the highest level set to 53 °C, surface temperature exceeds 55 °C within one minute, then enters holding mode and stabilises at approximately 53 °C. The difference between the two measurement points stays within 1 °C.

03 PROBLEM STATEMENT

Energy Storage Batteries in Low Temperature

In low-temperature environments the rate of the electrochemical reaction inside a battery slows down. Available capacity and output power fall, and because the internal reaction rate is reduced, both charge and discharge rates slow with it. For stationary storage this translates directly into lost availability and lost revenue during exactly the periods when demand peaks.

< 10 °C

Trigger threshold

Heating activates automatically below this point

10 min

Pre-heat time

Pack brought to working temperature

1-2 mm

Total build thickness

No usable pack volume is lost

04 SOLUTION

CNT Heating Jacket for Battery Packs

The CNT heating film is wrapped around the storage cells as a protective jacket. The pack's BMS monitors temperature and controls pre-heating. This approach brings the pack up to working temperature within 10 minutes while maintaining good temperature uniformity across the cells.

Advantages

- Surface heating — heat is even and controllable, with no risk of damage to the original equipment.
- Flexible film (1-2 mm) is bonded to the cell surface and occupies no meaningful pack volume, so unit dimensions are unchanged.
- Intrinsically low sheet resistance means very low energy consumption while heating.
- Deployed as a jacket, the system retrofits to existing pack designs without redesigning the enclosure.

Dual-sensor control logic

Sensor	Position	Function
Sensor 1	External to the pack	Detects ambient temperature reaching the critical value (< 10 °C).
Sensor 2	Internal to the pack	Confirms cell temperature < 10 °C; heating starts automatically.
Hold mode	Internal feedback loop	When sensor 2 reads 10 °C, the system switches to holding mode.

Deployment summary

A heating jacket is built from the CNT resistive layer and fitted around the cells. The pack BMS monitors temperature change and controls pre-heating, achieving working temperature within 10 minutes with good temperature uniformity throughout.

NEXT STEP

Build It With FlexTherm

FlexTherm develops and manufactures carbon nanotube flexible heating systems for brands, OEM and ODM programmes worldwide. Every solution in this document can be tailored to your geometry, voltage, temperature profile, control logic and certification requirements.

Custom development Heating film layout, flexible electrodes, NTC control board and firmware developed to your specification.	Compliance support RoHS, CE and electrical safety documentation prepared for your target market.
Sampling & scale-up Prototype samples first, then validated tooling and mass production.	Talk to us Shanghai Burning New Material Co., Ltd. — FlexTherm carbon nanotube heating systems.