

AUTOMOTIVE OEM & TIER-1

Automotive Thermal Management Solution

CNT flexible heating for traction batteries, seats and cabin interiors in electric vehicles.

- 200%+ range improvement in low temperature vs. an unheated pack
- Seat heating at ¥28 per zone with 30%+ lower energy use
- Cabin heating using 98.5% less energy than a PTC system

FlexTherm · Shanghai Burning New Material Co., Ltd.

Technical & Commercial Solution Brief · AUTO-EN-2.0 · English Edition

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 MARKET PAIN POINT

Winter Range Loss in Electric Vehicles

As charge cycles accumulate, expected range begins to decline — and the problem erupts in winter. “Range”, “energy saving” and “cost reduction” have become the annual keywords for both carmakers and owners, and remain unsolved to this day.

FlexTherm addresses this across three vehicle systems.

1. Lithium pack low-temperature solution Pre-heats the traction battery so usable capacity and charge acceptance return quickly.	2. Seat heating solution Lower cost per zone than conventional heating, with better contact and lower energy use.	3. Cabin space heating solution Radiant interior heating that replaces high-consumption PTC air heating.
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04 TRACTION BATTERY

Lithium Pack Low-Temperature Solution

Using a CNT heating system in low-temperature conditions can improve range by more than 200% compared with an unheated pack, retaining 80–90% of normal-temperature range.

Deployment	Method	Characteristics
Heating jacket	A protective jacket built from the resistive heating layer is fitted around the pack; the BMS monitors pack temperature and controls pre-heating.	Brings the pack to working temperature within 10 minutes and maintains good temperature uniformity.
Embedded array	The flexible film is bonded directly onto cell surfaces.	Film is thin (1–2 mm) so it occupies very little pack volume. Compared with PTC heating pads, it achieves a higher rate of temperature rise at lower energy consumption.

Theoretical calculation

–15 °C to 0 °C

Ambient range

Validated operating window for the calculation

15 min → 30 K

Temperature rise

CNT heating system running for 15 minutes

~30 W

Power output

Supplied from a 12 V battery

Result

Under these conditions the lithium pack is held within the optimum 10 °C to 30 °C start-up temperature range.

System integration

- The thermal management system consists of film heating pads plus integrated control.
- The heating control system can be integrated into the battery BMS.
- The CNT thermal management system runs at low drive voltage with low power consumption.

05 SEAT HEATING

Seat Heating Solution

Heating zones cover the backrest, the seat cushion and the leg support.

¥28 / zone

CNT seat heating cost

Integrated cost per heated zone

¥35 / zone

Conventional solution

Integrated cost of a traditional heating system

30%+

Energy saving

Lower consumption than conventional heating

Advantages

- Does not obstruct seat ventilation.
- Simple assembly — heating units can be pre-perforated to match the seat's own perforation pattern.
- Bonded during assembly using the pad's own backing adhesive together with a fixture.
- Sits close to the surface, so heat reaches the occupant's back, hips and legs directly.
- Energy saving: outstanding electro-thermal conversion reduces energy consumption by more than 30% versus conventional solutions.

Technical extension

The high thermal conductivity of carbon nanotubes supports a “one source, multiple paths” design: a single heating source distributes heat through the CNT film along several conduction paths, providing radiant heating for the whole seat.

06 CABIN HEATING

Interior Space Heating Solution

Air-conditioning consumption in an electric vehicle depends on ambient temperature and mode. In cold regions, EV heating normally relies on a PTC (positive temperature coefficient) heater drawing up to 9,500 W — more than the vehicle consumes cruising at a steady 60 km/h (around 7,000 W). This is the main reason range collapses in winter.

98.5%

Energy saved vs. PTC

Cabin thermal management instead of PTC air heating

3 m³ / +10 °C

Reference case

Cabin volume heated by 10 °C

~120 W·h

System consumption

Total consumption for the case above

- CNT film has cloth-like thinness and flexibility, so it can be embedded completely within the vehicle interior trim.
- Replacing air-conditioning heating with CNT interior surface heating delivers substantial energy savings across the whole cabin.
- In an electric vehicle, CNT interior space heating consumes 98.5% less energy than a PTC system.
- The energy saved goes directly back into driving range.

Data source: <https://new.qq.com/rain/a/20230404A05R3700>

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.