

The logo for FLEXOO, featuring the word "FLEXOO" in a bold, sans-serif font. The "O"s are stylized, with the second "O" being orange and the first "O" being black. A vertical orange line is positioned to the right of the logo.

FLEXOO

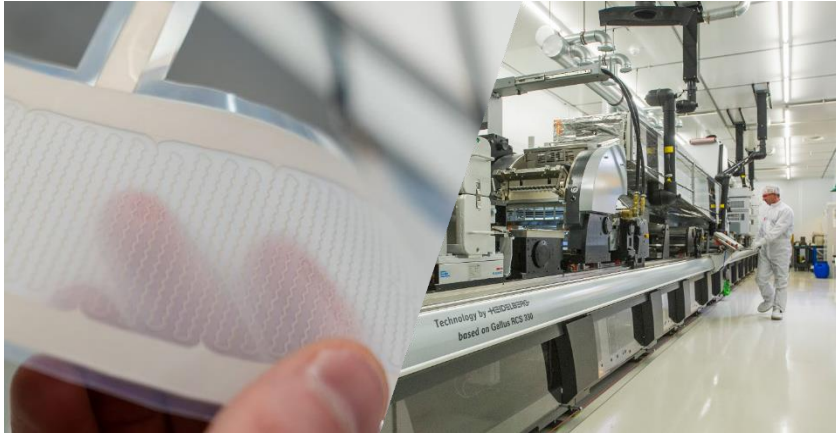
Printed Heaters Technology

FLEXOO GmbH
an InnovationLab company

Printed Heaters

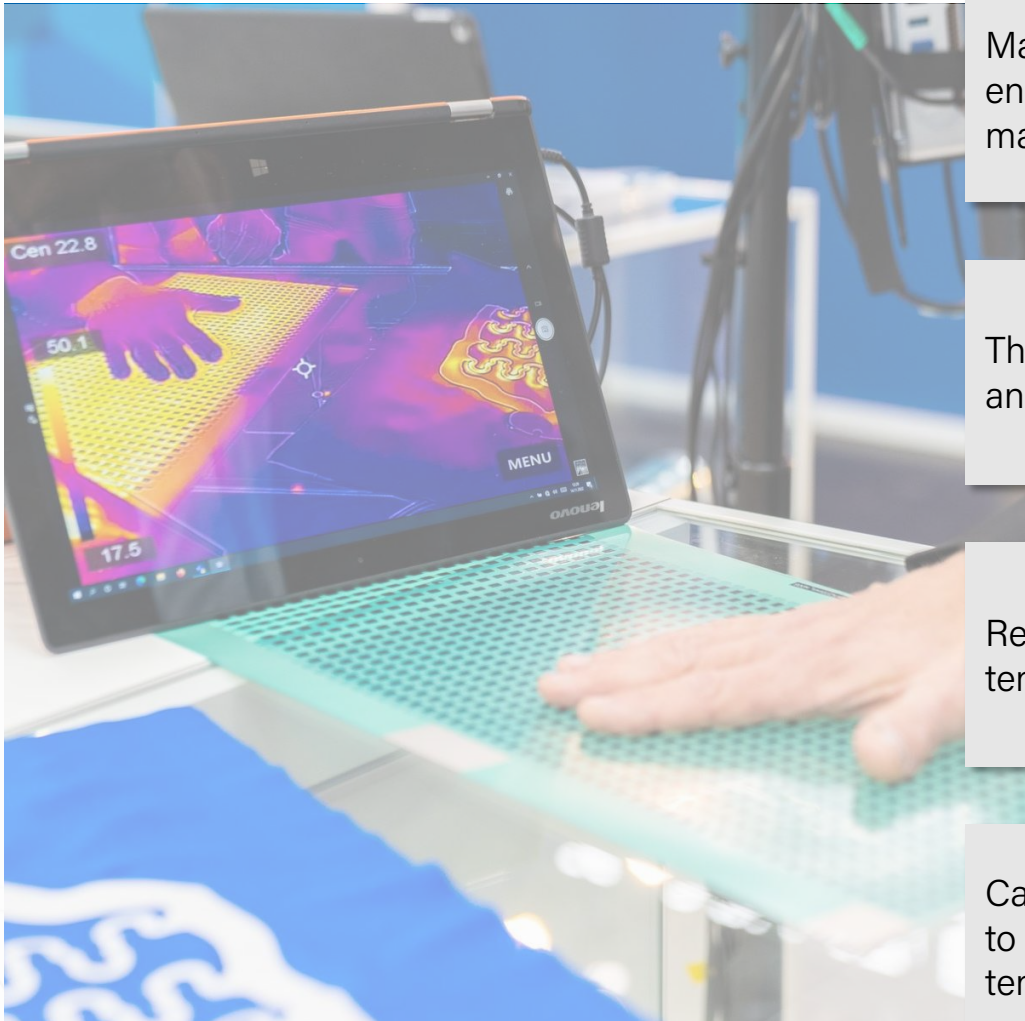
What Does It Mean?

FLEXO



- Printed functional ink on a flexible substrate using conventional printing processes
- **Substrate** is typically a carbon-based foil like PET, PEN or PI. Thickness typically varies between some microns to some hundred microns
- **Functional conductive ink** heats up, when voltage is applied

Generals Advantages at a Glance



Material and energy efficient manufacturing process



LOWER PRODUCTION COSTS + MORE SUSTAINABLE

Thin, light-weight and flexible



INTEGRABLE INTO A BROAD VARIETY OF APPLICATIONS

Reach the peak temperature very quickly



FAST HEATING UP

Can be self-regulating to specific threshold temperature



HIGHER SAFETY

Opportunities with PTC Heating Technology

Example: Car Seat Heating

Standard Integrated Heating Technology...

... needs bulky heating wires, thus...

- (insulation) cushion on top is necessary,
- takes a long time to heat up due to cushion
- and wastes a lot of energy

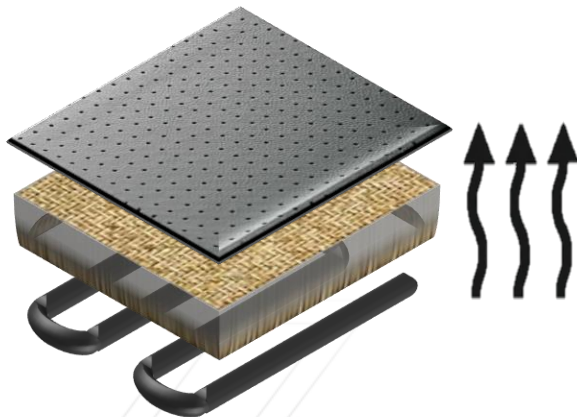
... can overheat, melt or cause damage, thus...

- needs a thermostat to avoid the risk of overheating

Seat Cover

Cushion

Heating Wire



Printed Heaters Technology...

...are produced on **very thin** and **flexible** substrates, thus...

- can be placed **directly below cover**
- heat is much **faster** where it should be
- consumes **less energy**

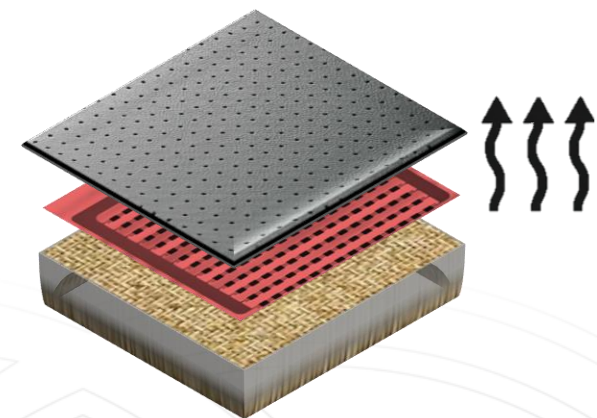
...physical temperature limit for printed PTC heaters, thus...

- regulation electronics is not needed

Seat Cover

Printed Heater

Cushion



Scope of Possible Applications



Automotive

- Seat heating
- Steering wheel warmer
- Armrest heating
- Defrosting of elements



Healthcare

- Heated belts for pain relief: thermotherapy
- Heated bedding for infants



Textiles

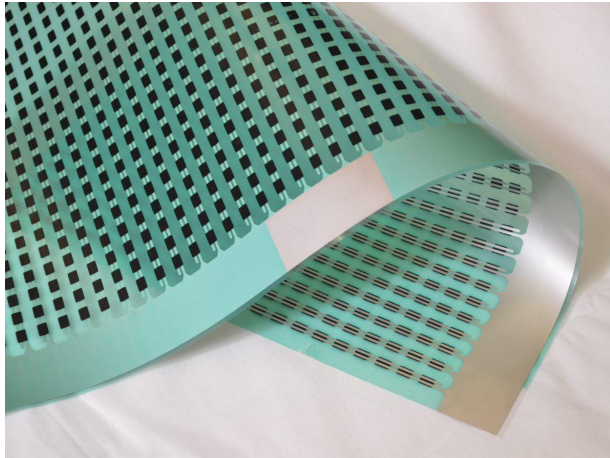
- Textile integrated heater (e.g. jackets, shirts)
- Wearable heater
- Heated gloves
- Heated shoe soles



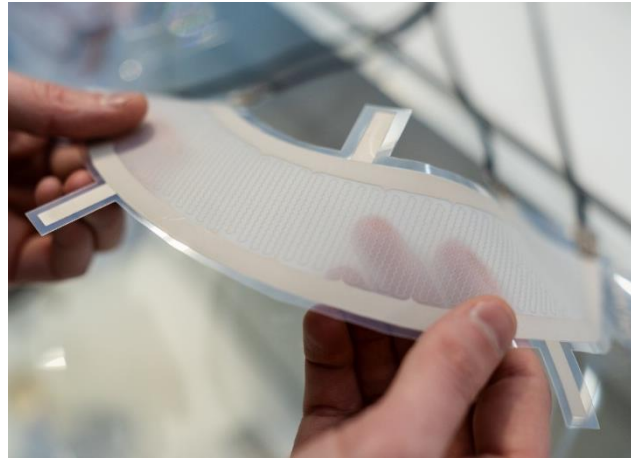
Aviation

- Deicing of plane's elements

Our Heaters Portfolio



Self-limiting (PTC) heaters



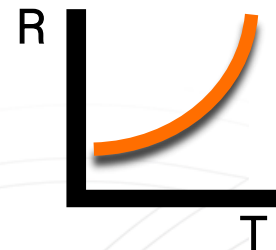
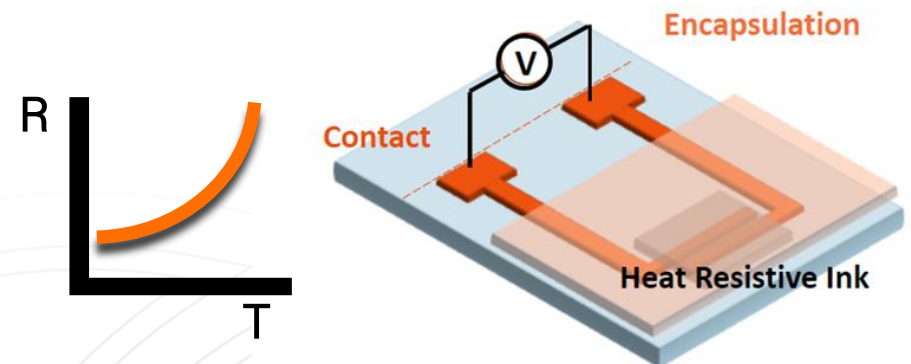
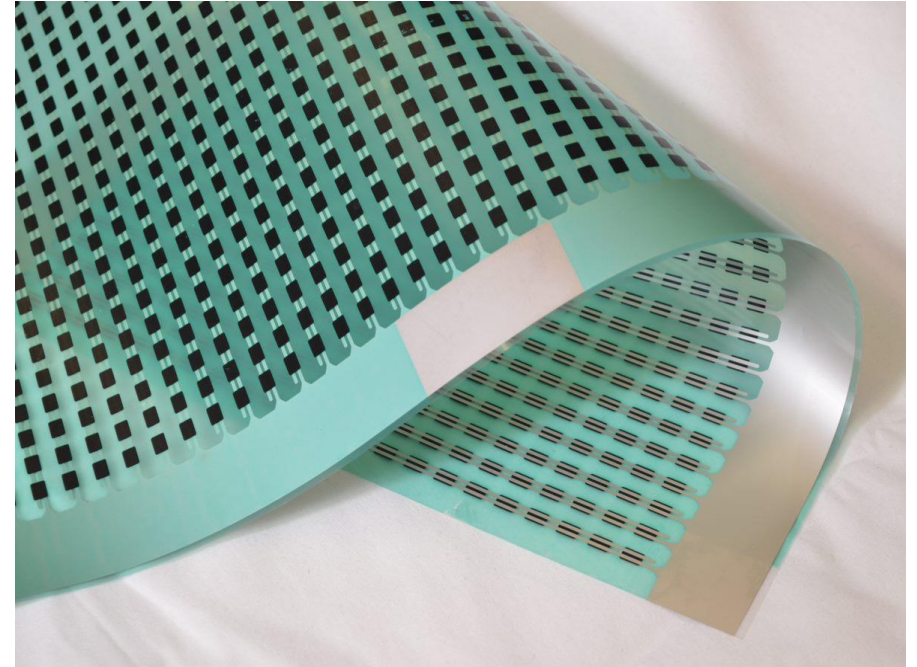
Translucent heaters



Stretchable heaters

Self-limiting (PTC) heaters

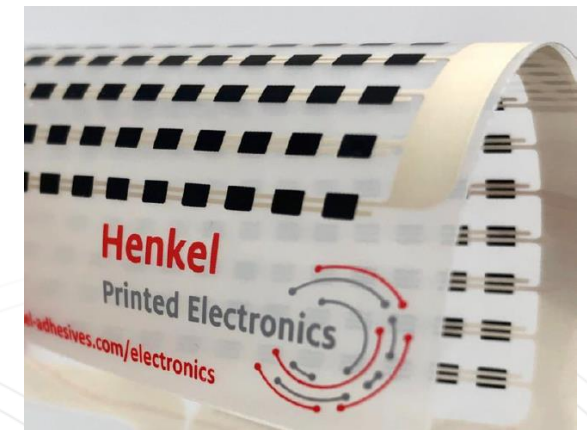
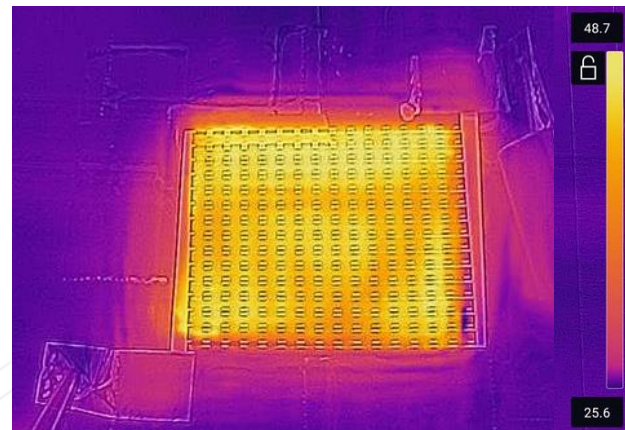
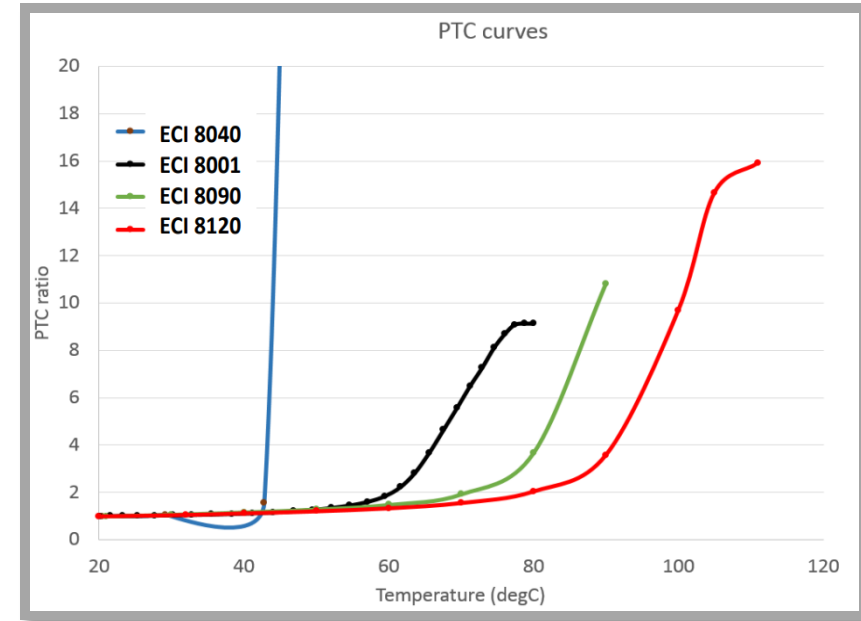
- Idea: heater stops heating at a certain temperature by itself.
- For this, carbon-based inks with a **Positive Temperature Coefficient (PTC)** are used. I.e., resistance increases with increasing temperature.
- PTC inks have the special property that resistance starts to increase drastically at a certain **threshold temperature**.
- Thus, current as well as heating power is reduced, and a **self-regulating** behavior is the result.
- The threshold is **adjustable** by the right choice of ink.
- Typically produced in **screen printing** process.
- Manufacturing by printing process allows a **high freedom of form factor**.



Self-limiting (PTC) heaters

Example: PTC ink by Henkel

- Available on-set temperatures 43°C, 55°C, 60°C, 90°C and 105°C.
- Material is capable of low “switch-on” voltage (<12 V) as well as high (> 230 V).
- Easily integrable with further functions (e.g. sensors).
- Printable on various flexible and non-flexible substrates.
- Especially attractive in „Close-to-body“ applications, automobile and interior fitting heating elements.
- Long-life time and environmentally stable.



Translucent Heaters

- Type 1: Print very **thin conductive lines** on transparent substrate. Thus, most of the light shining onto the heater is transmitted.
- Use a **spacer fabric** plus **diffusor** and heater appears to be **homogenously transparent**.
- Challenge: maintain **both light and heat homogeneity** at complex shapes (far from trivial!).
- Stack is simple: busbars & fineline prints plus encapsulation. Possible on a broad variety of substrates.

Example 1: Using fineline ink by ELANTAS



- Realized on PET and PI
- Starts to heat at some volts of operation voltage
- Features excellent heat homogeneity
- Heats up to 200°C on PI substrate

Translucent Heaters

FLEXO



MARQUARDT

Example 2: Semi-transparent heater in concept car by Marquardt

- In a common project with Marquardt, we mastered the challenge of **homogenous temperature and translucency** at the same time, despite the complex shape of an armrest.
- Integrated LEDs behind the heating elements enable **exceptional design features** in a heated armrest.
- Generates a pleasant warmth of 40°C - 60°C.
- Heat power/area of up to 82 mW/cm², continuously tunable.
- Low operating voltages of ~ 2-3 V.

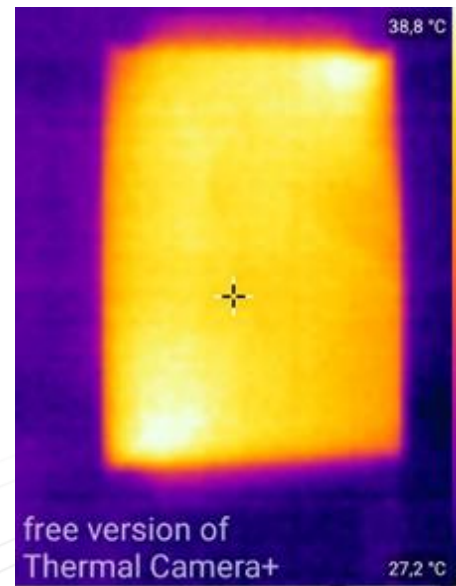
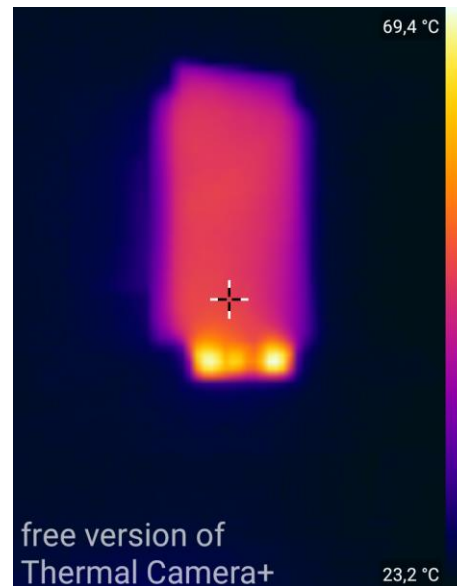


Check out the special effects in this [video](#) by OE-A.

Translucent Heaters

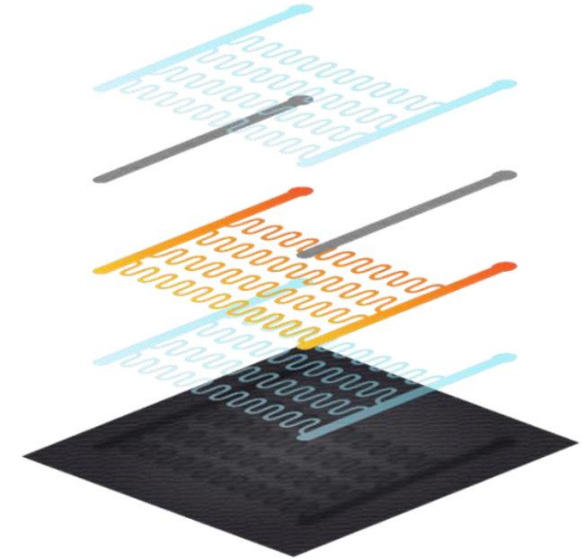
- Type 2: Based on **silver nanotubes** and therefore **close to fully transparent** (~ 98%).
- Excellent homogeneity regarding heat and transparency.
- Printable on various flexible and rigid substrates.
- Capable of heating up to 120 °C with a high-power density of up to 3000 W/m² (300 mW/cm²).
- Especially attractive for automotive headlights and optoelectronic applications.

Example : Transparent Heater with ink by CHASM



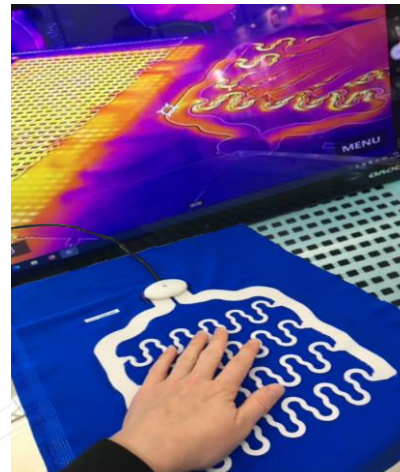
Stretchable Heaters

- Challenge: materials must not break even after repetitive stretch have to be aligned to each other.
- The conductive layer is crucial: Resistance must be constant both during elongation and after repetitive stretching.
- Typically on TPU or other elastomeric substrates
- Can be thermo-transferred onto textiles.



Example: Demonstrator with ink by ACI Materials

- Full compatible system including all layers, based on fixed resistance stretchable polymer.
- Stable heating homogeneity for ~ 20 % stretch
- Powered by regular USB
- Can be made washable by the use of right electrode and encapsulation material.



Before Wash



After Cycle 15



Collaboration & Partnership

Partnership based on bilateral expertise

Broad network of leading ink and materials providers to bring the best solution to our customers.



Customers who trust us

FLEXO



NEC

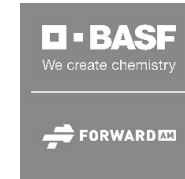
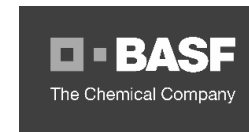
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RECARO



HEIDELBERG



tacterion



vibrosonic



Challenge us



Bart Jarkiewicz
Technical Sales Manager



Lars Keiz
Product Manager Battery Monitoring
Solutions



Dr. Florian Ullrich
Head of Business Development

[Schedule an appointment](#)