

High Voltage E-Heater – Simplified design thanks to innovative hybrid ceramics

Electric air heaters (E-Heaters) have been established in automotive and industrial applications for several decades. They have taken on new significance, particularly with the advent of electromobility: while combustion engines were able to heat the interior of the vehicle with their waste heat, battery-electric vehicles require an independent, efficient heat source. This is where high-voltage (HV) air heaters come into play. They convert electrical energy directly into heat, enabling fast, reliable heating of the incoming air.

(In addition to the automotive industry, e-heaters are also used in industrial processes, medical technology, and aviation—anywhere where rapid heat supply is required.)

State of the art - Heating rods

The heating elements in the High Voltage E-Heater are made up of several functional layers and materials:

- **Ceramic elements** as an electrical insulation layer. The ceramic is additionally coated on both sides with thermal paste, which leads to a reduction in thermal (contact) resistance.
- **Contact paths and conductor** tracks for the power supply.
- **PTC bricks and frames**
- If necessary, **Kapton® film** or comparable insulation film for additional electrical insulation.

This multi-layer structure has several disadvantages, particularly due to the increasing demands on power density and robustness:

- **Complexity in manufacturing:** Many individual steps and materials must be precisely coordinated and assembled.
- **Time required for production:** Each additional layer means more process steps, which increases manufacturing costs. The screen printing process for the paste in particular is both time-consuming and complex.
- **Prone to errors and inefficient:** The more interfaces and transitions there are, the higher the probability of contact problems or inefficient heat transfer. In addition, severe temperature cycles and mechanical stresses such as vibrations can cause the thermal paste to separate or lose contact with the housing.



Schon gewusst?

Die KP100 stellt hier durch deine speziell abgestimmte Verfüllung einen neuen Lösungsansatz dar.

The innovation from Kerafol - HYBRID CERAMICS

Kerafol has developed an innovative design that addresses these challenges and significantly simplifies the structure of the high-voltage e-heater.

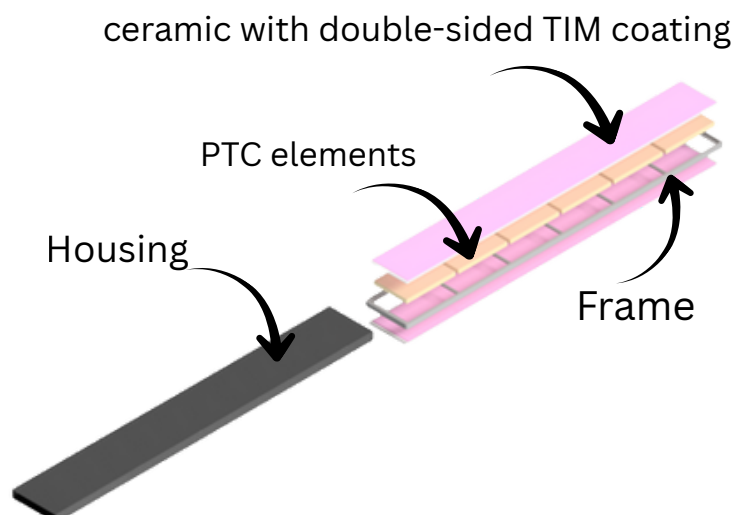
The design

Instead of the combination of Kapton®, separate contact paths, and an additional ceramic layer, a ceramic coated on both sides with “thermal conductive foil” is used. The ceramic is coated with a thermally conductive suspension using a special process carried out directly at Kerafol. After the suspension has been applied, the coated ceramic is dried, causing the previously viscous thermally conductive mass to cross-link and form an ultra-thin layer (up to 50 µm). The hybrid structure eliminates the need for the customer to screen print a thermal paste. The cross-linking of the suspension on the ceramic surface creates an air-free bond, which significantly reduces thermal resistance compared to subsequent joining of film and ceramic.

zu einem nachträglichen Fügen von Folie und Keramik.

This solution integrates several functions into a single material:

- **Mechanical stability** thanks to the ceramic support structure.
- **Optimized heat conduction** thanks to heat-conducting film coating on both sides.
- **Higher cycle stability** thanks to cross-linked TIM – No “pump-out” effect
- **Electrical insulation** without additional insulation films.
- **Surface bonding** is simplified and improved by the coated thermal conductive film.



Advantages of the new structure

- **Reduced complexity:** fewer components and interfaces.
 - **Reduced production costs:** The complex process step of “screen printing” is no longer necessary for the customer.
 - **High reliability in application:** Thanks to networked TIM – No “pump out” effect
 - **Increased efficiency:** Optimized heat transfer thanks to integrated solution.
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Significance for the future of e-heaters

Developments in the field of high-voltage heaters are taking place against a backdrop of growing demand for energy-efficient and space-saving solutions.

In addition, new applications are also opening up in other industries where compact, reliable, and easy-to-integrate heating solutions are in demand.

Conclusion



High-voltage e-heaters are a key technology for electromobility and many other industries. While conventional solutions are based on a complex layered structure, the ceramic developed by Kerafol, which is coated on both sides with thermal conductive film, offers an innovative approach: it simplifies the structure, saves time in production, and increases reliability at the same time. This material solution thus sets new standards for the next generation of high-voltage air heaters.

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