

## Thick Film Heater Technology

When Conventional Heaters Just Won't Do



Chromalox is all about precision heat and control. And no single product exemplifies this more than Chromalox® Thick Film Heaters. **Chromalox® Thick Film Heaters provide the best possible combination of heat transfer, thermal efficiency, and temperature uniformity** in applications where there is a need to save space in a product design.

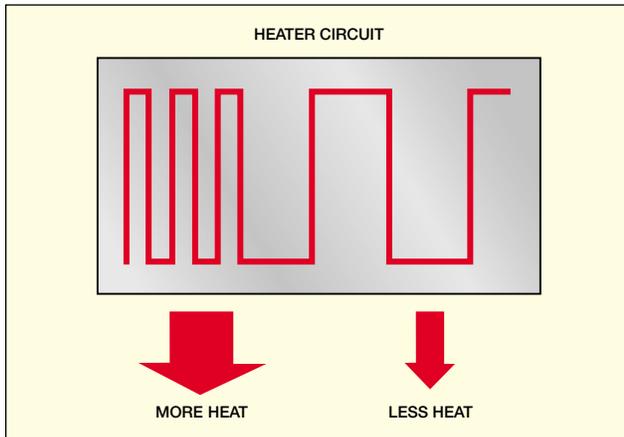


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## Chromalox® Thick Film Heaters Put Heat Precisely Where You Want It

Thick film heaters apply heat directly to an application by surface contact. This allows the heat to be put precisely where it's needed.

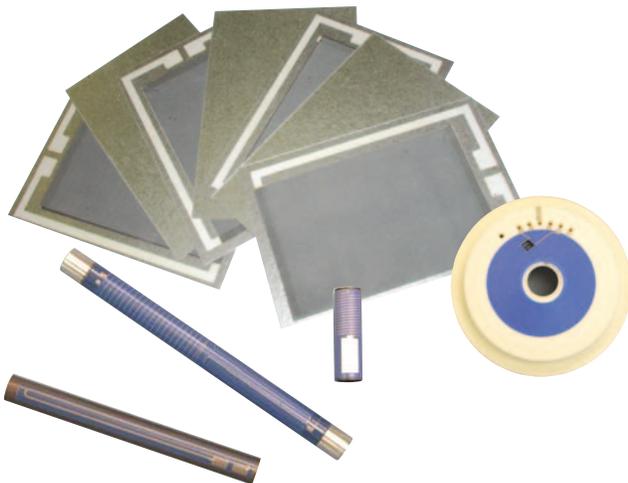
Chromalox® Thick Film Heaters can reach a maximum operating temperature of up to 500°C (932°F), depending on the application and substrate material. Watt densities can range up to 77.5 W/cm<sup>2</sup> (500 W/in.<sup>2</sup>).



Varying Heat by Varying Circuit Density

## Efficient Heat Transfer

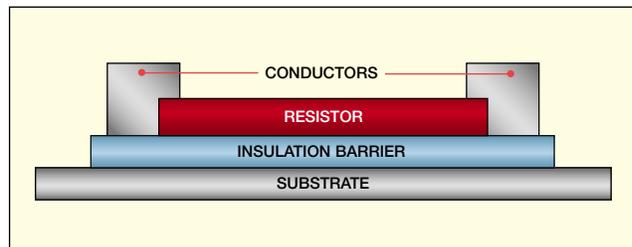
Direct surface contact ensures optimum heat transfer through low-mass, thermally stable substrates and fast thermal response for excellent operating efficiency. Thermal profiles can be maintained to less than ±1°C. By varying the density of the heater circuit, thick film heaters can be designed to vary heat output across the surface.



## Rugged Performance

Chromalox® Thick Film Heaters are designed to provide relentless, dependable, round-the-clock operation, week in and week out for years.

Thick film heaters are constructed of a substrate, a base dielectric material, and a resistor. Termination points are fused directly to the resistor circuit for strong, trouble-free connections. Thick film heaters are corrosion-resistant, contributing to their long service life.



Thick Film Heater Construction

## Use Them Where There's Limited Space or to Improve Product Design

The low-profile, compact design of Chromalox® Thick Film Heaters enables them to be used in existing applications where space is at a premium or where conventional heaters cannot be used because of limited voltage and wattage combinations. In new applications, Chromalox® Thick Film Heaters can improve product design because it allows manufacturers to save space while delivering greater heat transfer and faster heat-up.

Chromalox® Thick Film Heaters can be designed to fit around obstacles such as notches, posts, and mounting holes and brackets. They can be configured to virtually any flat, two-dimensional geometric shape, and to conform to any curved surface, concave or convex. Chromalox can even put thick film heaters on the inside of tubes!

## Multiple Substrates

Chromalox draws upon an experience base of 25 years in thick film and resistor technologies to provide solutions on substrates such as:

- Stainless steel
- Glass
- Quartz
- Ceramic
- Steel

## Chromalox® Thick Film Heaters Are Ideal for a Variety of Applications

Chromalox® Thick Film Heaters offer efficient heating for appliances, localized and concentrated heating for medical devices, and thermal uniformity with rapid heating and cooling for semiconductor fabrication. Some of the many other applications that can benefit by Chromalox® Thick Film heaters include:

- Semiconductor manufacturing
- Medical equipment
- Digital printing and copiers
- Food processing
- Gas and fluid heating
- Packagers and sealers
- Plastics processing
- Laboratory and analytical equipment



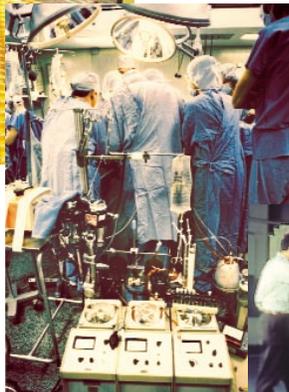
## Chromalox® Will Assist you Every Step of the Way

Experienced Chromalox engineers are available to assist you in the selection of the right Chromalox® Thick Film Heater for your application.

The Chromalox research and development staff can assist you throughout the design process. By working closely with your development team we can provide solid modeling, finite element analysis, prototypes, and extensive performance testing in our laboratory. Because Chromalox is a leader in custom controls and systems, we are able to couple your heater with an integrated control solution.

When a custom thick film heater is the best solution, Chromalox will assist you every step of the way—from prototype development and testing to production.

For assistance in selecting the right one for your application, or assistance with designing a custom solution, call us at **1-800-443-2640**. Or visit our website at **[www.chromalox.com](http://www.chromalox.com)** to locate a local field sales representative.



## General Specifications

<b>Substrate Materials</b>	<ul style="list-style-type: none"><li>■ Carbon Steel</li><li>■ Stainless Steel (304, 316, 430)</li><li>■ Ceramic (mullite, alumina, aluminum nitride, steatite, Macor® glass ceramic)</li><li>■ Quartz</li><li>■ Pyrex</li><li>■ PVC</li></ul>	<ul style="list-style-type: none"><li>■ PET</li><li>■ Aluminum</li><li>■ Mylar</li><li>■ Beryllium Oxide</li><li>■ Silicon Nitrate</li><li>■ Glass</li></ul>
<b>Paste Materials</b>	<ul style="list-style-type: none"><li>■ Conductive inks, resistive inks, dielectric inks</li><li>■ Cermet (for high-temperature applications)</li><li>■ Polymer (for low-temperature applications)</li><li>■ Exotic materials available upon request, or as determined by application</li></ul>	
<b>Patterning</b>	<ul style="list-style-type: none"><li>■ Minimum of 3 mil line deposition</li><li>■ Minimum of 1 mil line spacing</li></ul>	
<b>Sheet Resistivity</b>	<ul style="list-style-type: none"><li>■ Pd/Ag composites typically 6-35 mOhm/sq</li><li>■ Ag pastes typically 5-6 mOhm/sq</li><li>■ Au pastes typically 2-3 mOhm/sq</li></ul>	
<b>Resistive Range (Materials)</b>	<ul style="list-style-type: none"><li>■ End members range from 1ohm/sq to 10Mohm/sq for standard materials and down to 10mOhm/sq specialty</li></ul>	
<b>Resistive Range (Application)</b>	<ul style="list-style-type: none"><li>■ Traditional - 0.1Ohm to 1Gohm</li><li>■ MicroPen® - 1Ohm to 3Tohm</li></ul>	
<b>Power</b>	<ul style="list-style-type: none"><li>■ Standard up to 15.5 W/cm<sup>2</sup> (100 W/in.<sup>2</sup>)</li><li>■ Special up to 77.5 W/cm<sup>2</sup> (500 W/in.<sup>2</sup>)</li></ul>	
<b>Temperature</b>	<ul style="list-style-type: none"><li>■ Up to 500°C (932°F) application temperature</li><li>■ Thermal profiles maintained to less than ±1°C</li></ul>	
<b>Voltage</b>	<ul style="list-style-type: none"><li>■ Typical: 1-10 V/linear mils for resistor material</li><li>■ 100V/mil Ag Conductive</li><li>■ 1000-10000 V breakdown available</li></ul>	
<b>Patterning Available:</b>	<ul style="list-style-type: none"><li>■ Flat surfaces</li><li>■ Cylindrical – Exterior</li><li>■ Cylindrical – Interior</li><li>■ Non-linear cylindrical</li><li>■ Concave surfaces</li><li>■ Obtuse surfaces</li></ul>	
<b>Size Limitations</b>	<ul style="list-style-type: none"><li>■ Maximum producible volume: 22"L x 22"W x 3.5"H</li><li>■ Maximum in small batch quantities: 24"L x 36"W x 6"H</li></ul>	

\* Macor is a registered trademark of Corning Incorporated. MicroPen is a registered trademark of Ohmcraft, Inc.

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