FRALOCK® *Leading the Way in Advanced Materials Solutions*

# FRALOCK HEATERS FOR AEROSPACE AND MILITARY DEFENSE APPLICATIONS

Fralock provides custom-engineered heating solutions used in today's most demanding spacecraft, aircraft, satellites, and military defense applications. We offer multiple material constructions to optimize your temperature and thermal control requirements.

**Flexible Heaters** provide high flexibility and low mass, and can be shaped and formed to solve complex packaging challenges. Flex heaters are made with polyimide, either without adhesives, with Teflon or acrylic adhesive.

**Ceramic Heaters** made with Aluminum Nitride and Tungsten traces are designed for thermal uniformity and extremely rapid thermal cycling in precision critical equipment.

### Heater Types and Properties

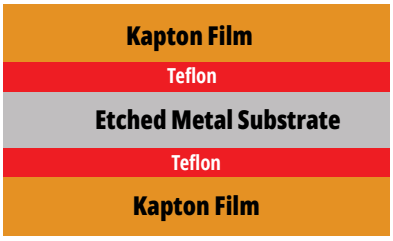
| Heater Type | Temperature Range | Material | Structural Formats | Power Density |
|---|---|---|---|---|
| All-Polyimide | -269°C to +250°C | Polyimide lamination<br>No adhesives | Flat, formed to most surfaces | 40 W/sq in + |
| Polyimide with Acrylic Adhesive | -198°C to +125°C | Acrylic | Flat, formed to most surfaces | 20 W/sq in + |
| Polyimide with Meltable Teflon | -240°C to +205°C | Teflon (PTFE) | Flat, formed to most surfaces | 30 W/sq in + |
| Ceramic AIN | -250°C to 700°C | AIN, Tungsten | Platens or tubular | Small format 2KW/sq in 300 mm<br>10- 15kW Pending configuration |

## FLEXIBLE HEATERS

Fralock's flexible heaters can be fabricated using multiple material configurations to meet your needs. Etched foil heating elements can be assembled to the surface of the heater or embedded inside for a one-piece solution. There are also several mounting options available to ensure quick and effective heat transfer. Adhesive and adhesiveless lamination constructions are available.

All Polyimide Adhesiveless
(Fralock's Adheviseless Lamination Technology ALT™ )

Acrylic Adhesive



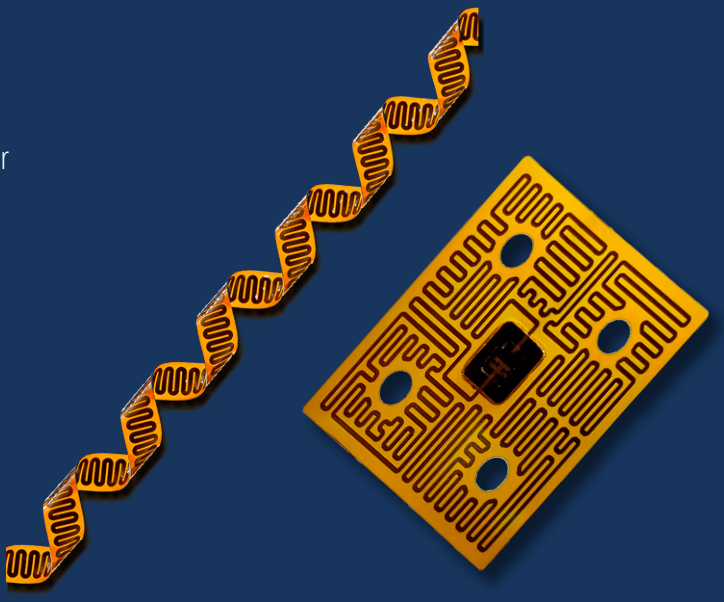

Meltable Teflon

## Applications Include

- Instrumentation
- Communication Equipment
- De-Icing & Anti-Icing
- Battery Warming
- Radar Systems, Antennas, and Testing Equipment
- Electronic Components Temperature Maintenance
- Fuel and Hydraulic System Heating
- Military Equipment and Vehicles
- Medical and Life Support Equipment such as medical imaging systems, ventilators, and monitors.
- Cameras and optical components
- Space crew capsules

## All-POLYIMIDE FLEX HEATERS - with Adhesiveless Lamination Technology (ALT)™

- Several dielectric and foil options available
- Flexibility for heating complex, three-dimensional applications
- Low mass with average 20% mass savings over classic foil heater construction
- Low profile - as thin as 0.0635mm (.0025")
- Multi-layer and multi-zone heating; can include embedded thermocouples
- Very good temperature range -269°C to +250°C
- Excursions capable up to +300°C
- Low out-gassing
- Connector integration and component assembly available



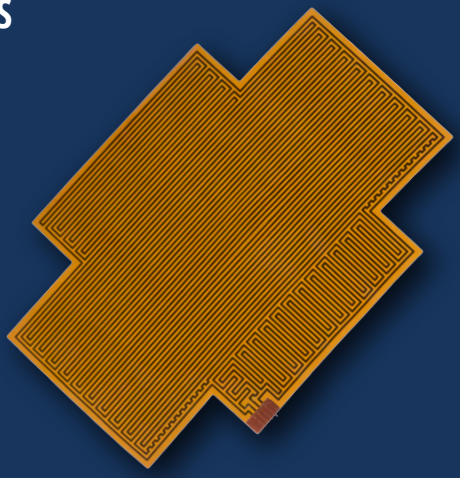
## Adhesiveless Lamination

Fralock has developed a unique capability to produce multi-layer, all polyimide heaters with technology that uses no adhesives of any type, called Adhesiveless Lamination Technology (ALT)™. Other competing constructions use adhesives that form weak links with physical properties which can interfere with the heaters' conformation and reliability.

## POLYIMIDE/ACRYLIC FLEX HEATERS

### FEATURES AND BENEFITS

- Several dielectric and foil options available
- Flexibility for heating complex, three-dimensional applications
- Low profile - as thin as 0.0635mm (.0025")
- Multi-layer and multi-zone heating; can include embedded thermocouples
- Temperature range -198°C to +125°C
- Connector integration and component assembly available
- Welding and soldering wire attachments



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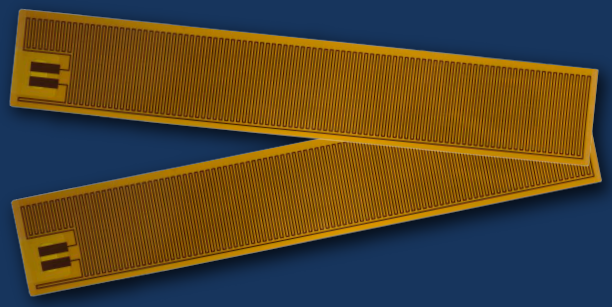
# POLYIMIDE/TEFLON FLEX HEATERS

## FEATURES AND BENEFITS

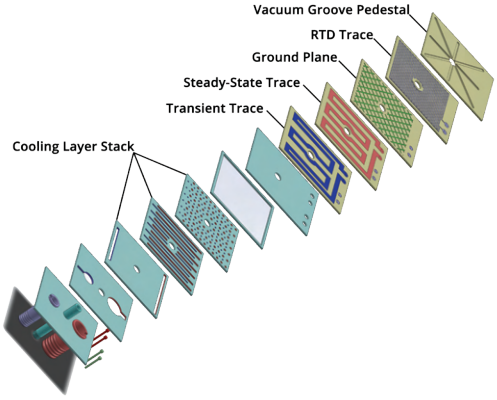
- Several dielectric and foil options available
- Flexibility for heating complex, three-dimensional applications
- Low profile - as thin as 0.0635mm (.0025")
- Multi-layer and multi-zone heating; can include embedded thermocouples
- Temperature range -240°C to +205°C
- Connector integration and component assembly available
- Welding or soldering wire attachments



# CERAMIC HEATERS

Fralock Ceramic heaters are made using high thermal conductivity Aluminum Nitride (AlN) with embedded Tungsten resistance heating traces, providing tailored power input to achieve your temperature transition goals.

Extremely rapid heating in excess of 300°C/sec is made possible because the coefficients of thermal expansion of Aluminum and Tungsten are equal (4.3 x $10^{E-6}$ Co). Integrated channel structure and low density AlN ceramic provide quick cooling rates, from 300°C to room temperature in a just few seconds.




*Expanded view of a rectangular heater*

| Properties | Aluminum Nitride | Tungsten |
|---|---|---|
| Linear Coefficient of Expansion per °C | 4.3 x $10^{E-6}$ | 4.3 x $10^{E-6}$ |
| Thermal Conductivity (RT) - W/mK | 180 | 170 |

Exceptional thermal uniformity and seamless transfer of temperature is achieved due to matched coefficients of thermal conductivity

## Applications Include

- Chip warming in drone and other aircraft cameras
- Satellite propulsion
- High thermal conductivity electrical interposers for drone electronics
- Electrode spacers in high voltage capacitors for high-energy pulse power systems
- Device Under Test thermal testing and class testing for chips used in aerospace applications

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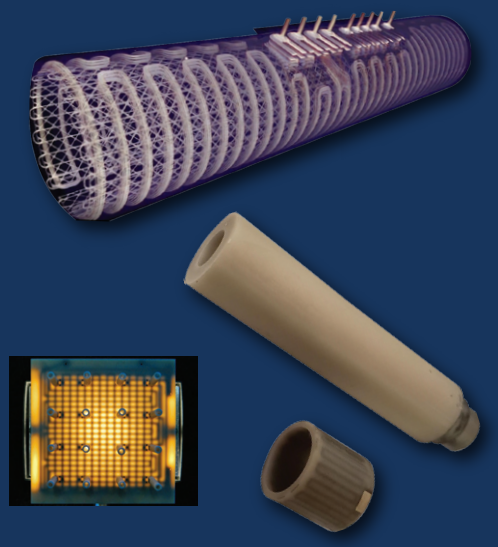
## FEATURES AND BENEFITS

- Robust reliability, proven with millions of cycles in the field
- Multiple zones of heater and sensor traces in various layers
- Tungsten traces are fully integrated and chemically bonded into the AlN microstructure
- Ground plane shielding
- Thin substrates: flat, round or any that geometry can be CNC milled
- Complex geometries that include venting, vacuum, and blind features
- Large format sizes up to 380mm diameter
- Internal cooling channels
- Sub-micron flatness possible



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**Let us help with your most challenging applications.**

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