



closing the loop on thermal solutions

Flexible Heaters of Silicone Rubber & Kapton®

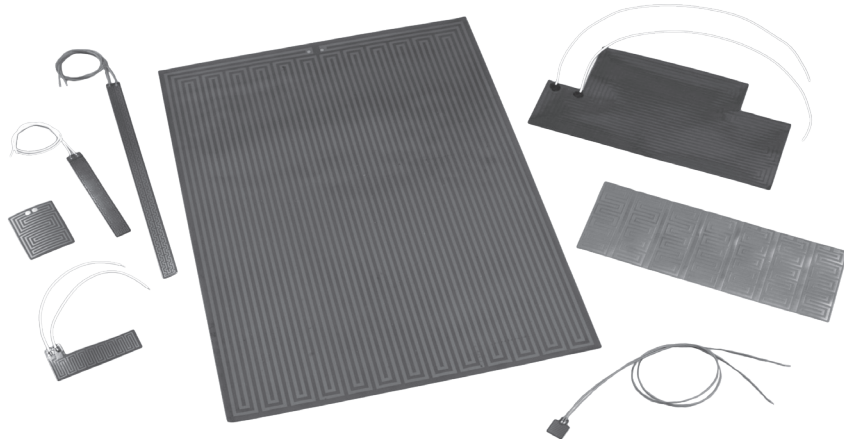
INTRODUCTION

Durex Industries flexible heating elements are providing customers their optimal thermal solution in over twenty different OEM markets. Durex's unique approach to flexible heating elements optimizes the product's design to meet the customer's most important requirements. This collaborative process, based on extensive experience with complex OEM product roll outs, assures that both business and technical requirements are optimized in the design. Please contact Durex Industries to take advantage of not only Durex's flexible heating elements but its business and technical expertise for increased value and product success.

Silicone Rubber Heaters



Kapton® Heaters



Flex Heaters

Design Features

Minimal mass

- Flexible insulations make up heating elements .060" or thinner

Ability to profile the watt density

- The concentration of heat can be adjusted in different sections of the heating element to take into account geometry and mass differences in the heated surface

Variety of shapes

- An infinite number of shapes are possible in order to match the shape of the heating element to the shape of the customer's part

Excellent thermal control

- Low mass and intimate contact of the heating element minimizes temperature overshoot

Creative product engineering

- Capable of fitting restrictive design parameters

Economical solutions in medium to large runs

- Utilizing lean and cellular manufacturing concepts allows for low cost products



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SILICONE RUBBER HEATERS

Durex's silicone rubber heaters take advantage of the unique properties of silicone rubber to provide heating elements of unparalleled performance. Silicone rubber is calendared onto fiberglass cloth in a variety of thicknesses and constructions which serves as the basis for Durex's silicone heating elements. Generally two layers of material containing an etched foil element or a precision wire wound element are vulcanized together to form a basic silicone heating element. The three most common constructions include:

- .030" nominal thickness suitable for etched foil elements and low cost construction
- .043" nominal thickness suitable for wire wound heating elements that are permanently attached
- .056" nominal thickness suitable for heating elements that are removable

Thickness will be greater over the power lead exit point and over any options such as thermostats or temperature sensors.

Specifications:

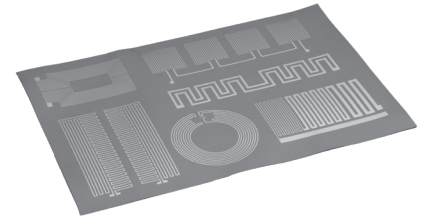
- **Sizes:** up to 36" wide (consult factory)
- **Standard Thickness:** 0.030", 0.043", 0.056"
- **Maximum Operating Temperature:** 400°F (204°C) intermittent
- **Minimum Operating Temperature:** -60°F (-50°C)
- **Maximum Watt Density:** 60 watts/in²
- **Maximum Voltage:** 600 volts
- **Wattage Tolerance:** standard +5% -10%

Features:

- High di-electric strength and resistance to electric fatigue
- Ozone, weather, and chemical resistant
- Flame retardant and non-toxic
- Low outgassing with no sulfur or nitrogen to create hazardous compounds that are prevalent in organic rubbers
- Proven thermal stability

Etched Foil Elements

Beginning with a Durex engineered photo tool, Durex photo develops and then chemically etches a highly precision, resistive foil circuit, to be vulcanized internally into a silicone heating element. Durex's silicone etched foil elements can have internal element coverage of greater than 50% of the entire heating element area. This coverage lowers the internal heating element temperature providing longer heating element life. Etched foil elements are superior for high watt density and higher temperature operation. In addition, because the circuit trace width can be varied in the design and manufacturing process, etched foil elements are ideal for distributed watt densities within the same heating element. Durex's efficient production methods result in etched foil being the better choice for low cost, high volume runs of smaller size heating elements.

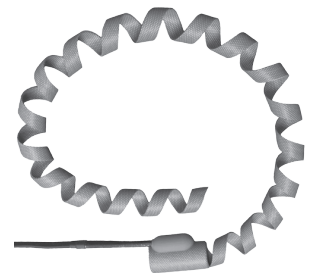


Wire Wound Elements

Beginning with a computer designed, dedicated, winding pattern and tool, Durex manufactures precision wire wound silicone rubber heaters. Durex engineers select various combinations of resistance wires to be combined or stranded together to produce the optimal result. In many cases the resistance wire is wound around a fiberglass core for added strength and flexibility. Durex's silicone heating elements may incorporate parallel redundant circuits depending on the application and electrical requirements. Wire wound silicone rubber heaters are generally most suited for larger heating elements, low watt densities, and smaller production runs.

Formed Heating Elements

Although most silicone rubber heaters are manufactured in a flat flexible shape, Durex regularly manufactures silicone rubber heaters in a variety of formed shapes. Forming can provide superior heat transfer, and ease of installation by the customer. A typical design would be a cylindrical shaped element that "snaps" onto a pipe of the same diameter. Using proprietary techniques, Durex can form silicone rubber heaters into more complex shapes depending on the customer's requirements.





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Engineering Specifications

Wattage

Durex can provide silicone rubber heaters with a variety of wattage and power options. Although uniform watt density (watts per square inch) is the most common configuration, Durex engineering can profile the power density to supply the heat where it is needed in the application. A common scenario is when heating a plate, the outer perimeter can be manufactured with a higher watt density to minimize edge loss and yield a more uniform temperature across the surface.

Silicone rubber heaters can also be provided with independent circuits so that two different power densities can be utilized. For example, a higher powered circuit could be used to bring a part up to temperature, while an energy saving lower powered circuit maintains the part at a desired temperature. This design feature can be beneficial with applications that are battery powered to conserve battery life.

Voltage

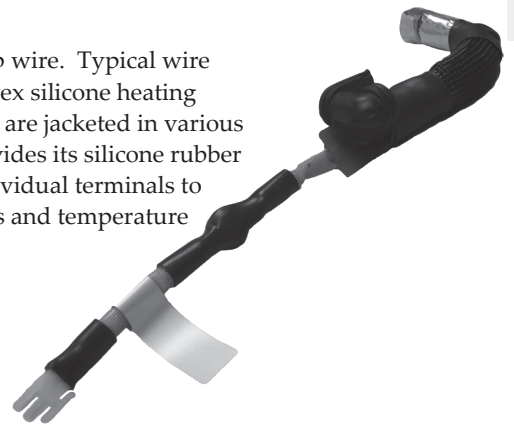
Durex silicone rubber heaters can be powered with voltages up to 600 volts in both AC and DC applications. For high voltage applications, Durex engineering will select the appropriate materials and design the elements to account for the higher dielectric requirements.

Dual voltage heating elements can also be provided by Durex. A common configuration would be a 120/240 volt heating element. This three wire lead arrangement allows the OEM customer to stock only one heating element that can be utilized in both their 120 volt and 240 volt machines. To accomplish this benefit, Durex engineering designs the heating element with two circuits that can be wired in either parallel or series to achieve the same wattage output for both voltages.

Independent four power lead, dual voltage heaters are also possible under certain situations. For the aerospace and aviation industries, Durex provides 28/120 volt heating elements that contain separate independent circuits to deliver the same wattages for either situation. Consult Durex engineering for assistance with any of these options.

Lead Wire Power Connection Options and Harnesses

Durex silicone rubber heaters can be furnished with a variety of lead wire or hook up wire. Typical wire type is Teflon insulated stranded wire. Stranded silicone wire is also often used. Durex silicone heating elements can be supplied with HPN or SJO type cord as well as individual leads that are jacketed in various sleeving. Utilizing both in house work centers and outside partners, Durex also provides its silicone rubber heaters with a variety of electrical connectors. These options can be as simple as individual terminals to complex multi-pin connectors that combine leads from multi-zoned heating elements and temperature sensors into one housing. This versatility provides Durex's customers with increased value in both production velocity and part number reduction.





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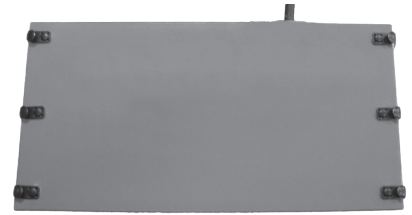
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SILICONE RUBBER HEATERS

Attachment Methods

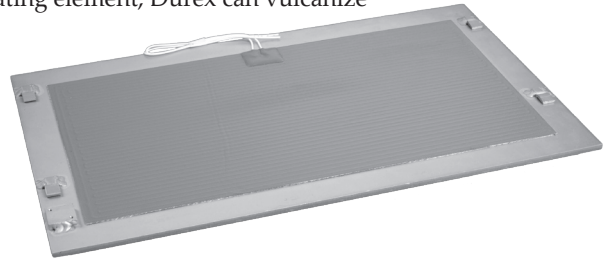
Durex silicone rubber heaters can be attached to customer parts by a variety of methods. Many factors can influence the optimal choice including heater watt density, operation temperature, geometry of part, and part material.

Contact Durex engineering to discuss the best method for a specific application.



Factory Vulcanization

Simultaneously with the vulcanization of the two silicone layers for the heating element, Durex can vulcanize (attach) the heating element to the customer's part. Factory vulcanization offers superior heat transfer due to the intimate and consistent bond. Factory vulcanization also offers the customer reduced manufacturing time, thereby increasing production velocity. Depending on part geometry, Durex uses several proprietary vulcanization methods to complete the process.



Pressure Sensitive Adhesive

Durex silicone rubber heaters can be furnished with pressure sensitive adhesives. These heating elements feature a removable liner to protect the adhesive before installation by the customer. Depending on the substrate material and the operating temperature, Durex engineers will select either an acrylic based pressure sensitive adhesive or a silicone based adhesive to best satisfy these requirements. Customer parts should be clean and free from oil and grease before attachment.



Silicone RTV

Durex silicone rubber heaters can also be attached with silicone RTV (room temperature vulcanizing). RTV can achieve a highly reliable bond and is suitable for high temperature operation. Two-part RTV may be required for large heating elements as one-part RTVs require humidity to cure properly. Consult Durex for installation assistance.

Attachments for Removable Heaters

For silicone rubber heaters that need to be easily removed from the part being heated, Durex has available a variety of attachment options. Most any attachment method that is available for fabric can also be utilized on silicone rubber heaters. These include grommets for lacing, grommets with springs and/or buckles, Velcro, Nylon or silicone straps with "D" rings, and straps in conjunction with ITW Nexus style two-part buckles. Consult Durex engineering to discuss the most appropriate option.



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Temperature Control

Thermostats

Durex silicone rubber heaters can be designed and manufactured with a variety of thermostats. Generally these thermostats provide over temperature (safety) control or temperature control in applications not requiring a tight, precise, temperature control.

Durex engineers can achieve a variety of results depending on the thermostat placement. For over temperature protection the thermostat is generally placed over a heated section so that the heating element does not exceed a maximum temperature.

By placing the thermostat over a non-heated section of the heating element, the thermostat will primarily monitor the customer part temperature. Durex engineers can increase or decrease the impact of the heating element on the thermostat by increasing or decreasing the size of the non-heated section.

Durex engineers can also mount the thermostat so that the sensing side is exposed to open air. This is commonly used in situations where the heating element is located in an electronic enclosure that is exposed to the environment and the heating element is used for condensation prevention or freeze protection.

Temperature Sensors

Durex silicone rubber heaters can also be furnished with temperature sensors that provide an electronic temperature control with temperature readings. Most common types are RTDs, thermistors, and thermocouples. These sensors can be mounted over a non-heated section to sense the customer's part temperature or over a heated section to control the temperature of the heating element itself. Because Durex is a manufacturer of temperature sensors as well as a designer of temperature controls, the customer can rely on a greater level of expertise than most flexible heater companies when the complete thermal system is designed.

Thermal Fuses

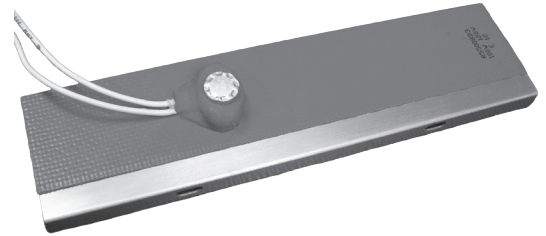
Thermal fuses are single use devices that can also be incorporated into Durex silicone rubber heaters. These fuses are commonly used as a fail-safe device to assure the shutdown of the heating element in the case where the primary or even secondary control has failed in critical applications. As with the other devices they can be designed and placed over a non-heated section or heated section depending on the desired result. Industry standards recommend an approximate temperature difference of 100°F between the primary temperature control setting and the thermal fuse setting to prevent nuisance tripping and premature aging of the thermal fuse.

Thermal Insulations

Durex can provide its flexible heating elements with a variety of thermal insulations in varying thickness and material types. For silicone heating elements, silicone sponge form 1/8" to 1/2" is commonly provided. Kapton® heating elements can be provided with silicone or engineered insulations depending on the requirements of the environment. Due to the efficiency of flexible heating elements, insulation is most often desired to reduce heating element surface temperature.

Agency Approval

Durex offers flexible heating element component recognition for both UL and Canada under UL file number E110394. Durex is continually increasing its product offerings and options under component recognition. Please call Durex for the latest inclusions. In addition, Durex product support can be a valuable resource in seeking approval for UL listing on OEM equipment as it relates to issues with heating elements as Durex has helped many OEMs with certification issues.





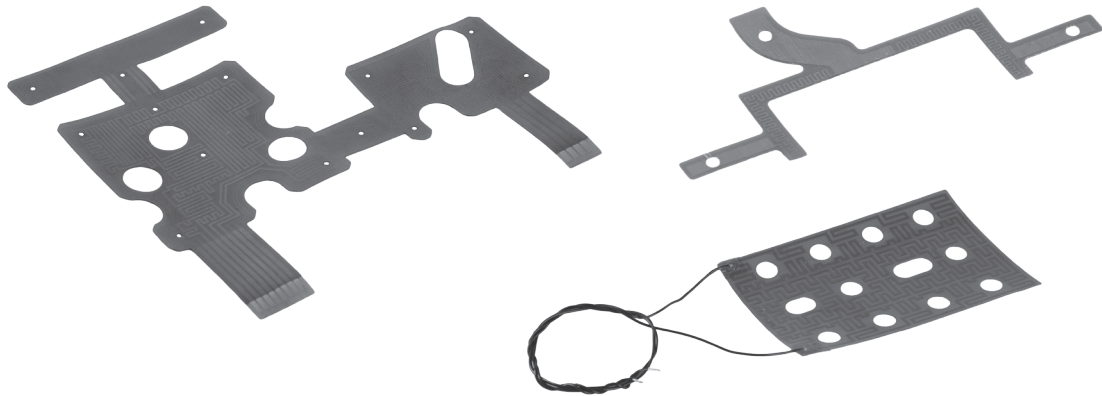
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KAPTON® HEATING ELEMENTS

Kapton® (polyimide) Heaters offer superior tensile strength and tear resistance, with precision heat distribution. Kapton® is an organic polymer with very high dielectric capabilities, while providing superior resistance to most solvents, oils, even radiation. Additional features include:

- Transparent Kapton® (polyimide) film for easy visual inspection on the internal structures
- Etched foil heating elements
- Kapton®, Teflon®, or Silicone leads



Specifications:

- **Sizes:** Custom, consult the factory for your application requirements
- **Standard Thickness:** 0.007"
- **Maximum Operating Temperature:** 392°F (200°C)
- **Minimum Operating Temperature:** -319°F (-195°C)
- **Standard Dimensional Tolerances:** Less than 12" ± 0.062 ", Greater than 12" ± 0.125 "
- **Maximum Watt Density:** 50 watts/in²
- **Wattage Tolerance:** standard $\pm 10\%$
- **Dielectric Strength:** 1000 VAC

Attachment Methods

Pressure Sensitive Adhesive

PSA is the most common option for mounting Kapton® heaters. By selecting proper materials, including the release agent, you can promote a strong bond and effective heat transfer.

Clamping

Kapton® heaters can also be clamped to their heating surface. A pressure plate is then fastened in place. To ensure even distribution of heat, and to protect the heater, a pressure pad or insulation layer is advised. The work surface should be free of any debris, dirt, chemicals, bumps, or grooves. This will protect the heater as well as prevent overheating.

Self-Fusing Tape

When mounting to a smooth cylindrical surface, Kapton® heaters can be mounted with self-fusing tape. This will provide a safe operation and even transfer of heat.

Temperature Control

For temperature control on Kapton® heaters, Durex recommends an RTD or thermocouple. Sensors are mounted to the surface of the heater and send a resistance measurement to an external controller that cycles the heater at a set temperature.

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