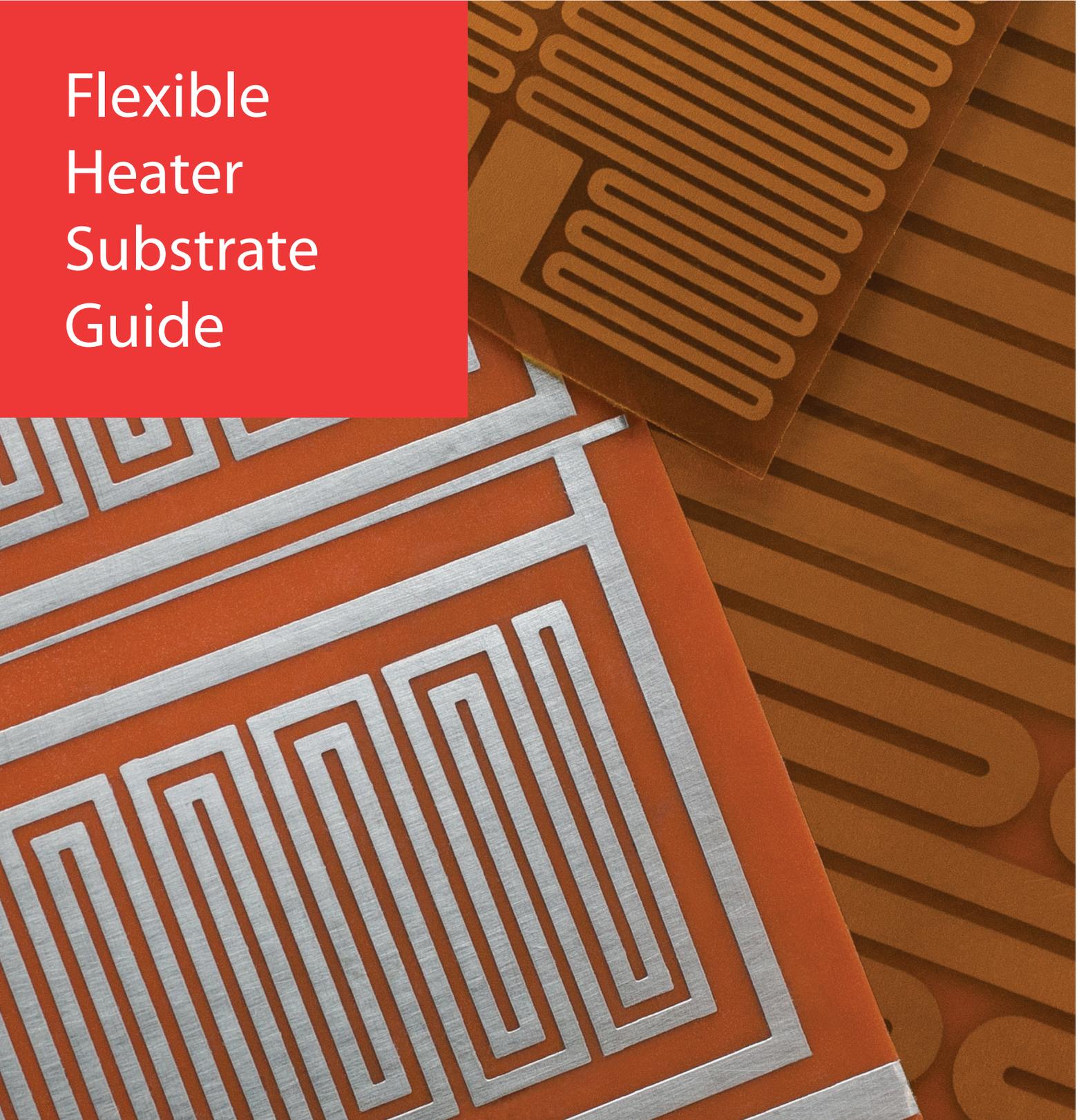


Flexible Heater Substrate Guide



ARLON® Flexible Heater Dielectrics

Lightweight

Thin design minimizes the material needed

Good Thermal Control

Rapid heating and distribution of thermal energy evenly across the surface

Highly Conformable

Bendable and flexible; can conform to complex geometries

Durable

Resistant to ozone, moisture, and many common environmental chemicals

Customizable

Available in various thicknesses and several colors

Quality Engineering

Precisely engineered to customer specifications

Thermally Stable

Thermally stable from -50°C to 232°C (-58°F to 450°F)

Flame Resistant

Horizontal burn rated at UL 94 HB. V-0 options available

High Dielectric Strength

Both silicone and polyimide have dielectric strengths exceeding 500 V/mil

Bondable

Compatible with silicone pressure sensitive adhesive; can be bonded to wire or metal foil elements

Economical

Cost-effective solutions

Reliable

Rogers' flexible heater reputation is unmatched in the industry

ARLON Heater Substrates

Rogers offers two lines of substrates for flexible heaters: silicone rubber and polyimide.

Standard Silicone Dielectric

The use of thin, flexible silicone rubber/fiberglass fabric composite materials is the standard for high temperature heaters. Rogers manufactures a full line of silicone rubber/fiberglass fabric composites with UL-recognized relative thermal index (RTI) ratings up to 220°C (428°F), flammability ratings for horizontal burn (HB), and the highest resistance to vertical burn (UL94 V-0) for electrical insulation of flexible heaters. These materials are available with pre-bonded resistive foils, such as Inconel 600 and stainless steel. This eliminates the initial bonding step which realizes reduced processing costs. Rogers' silicone rubber/fiberglass fabric composites operate reliably, and offer long service life in both wire-wound and etched foil heater applications.



Figure 1. Wire-wound flex heater with silicone substrate.

ARLON Heater Substrates

raPIId Polyimide Dielectric

ARLON raPIId polyimide substrates are comprised of a revolutionary new construction that incorporates the benefits of polyimide heater dielectrics with the flexibility and usability of a silicone adhesive system. The raPIId substrates process in less time and at lower temperatures than competitive acrylic or FEP adhesive systems with zero circuit swimming. The unique silicone adhesive system enables the manufacture of etched-foil and wire-wound flexible heaters with improved thermal stability and low outgassing performance. Flexible heaters manufactured with raPIId substrates have a continuous operating temperature of 220°C (428°F). They can be bonded to wire or metal foil elements at 121°C (250°F). In the event of an over-temperature situation, either due to a hot spot or a runaway heater, ARLON raPIId substrates will not melt like FEP fluoropolymer.

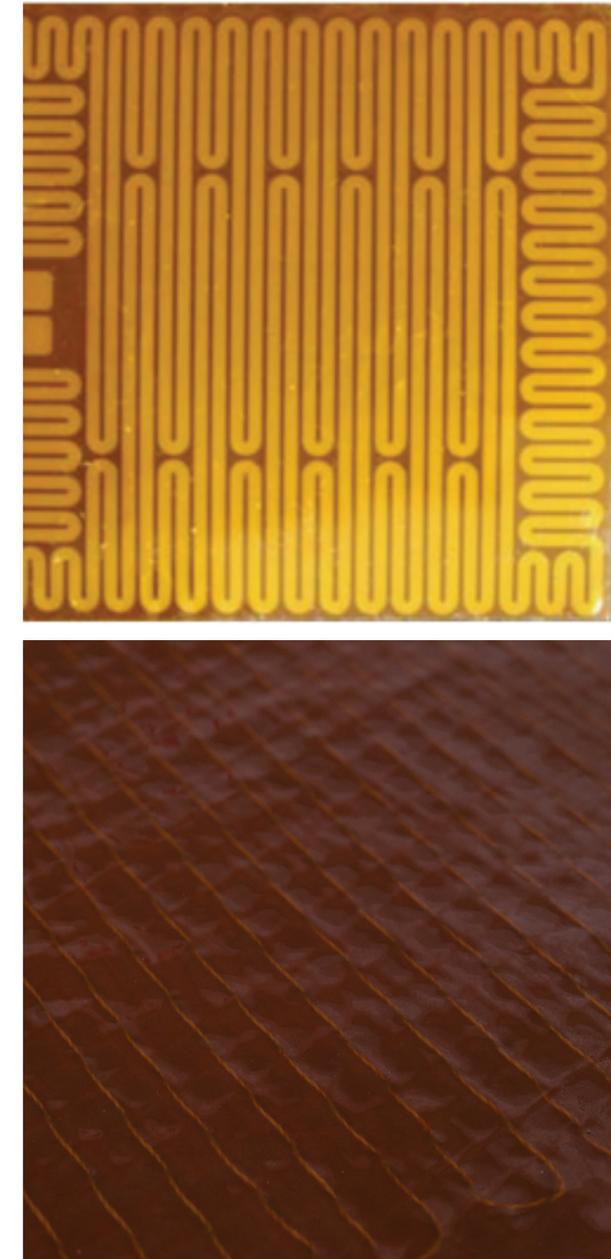


Figure 2. Etched-foil (top) and wire-wound (bottom) flex heaters with polyimide substrates.

Typical Material Properties

	ARLON SILICONE	ARLON raPIId POLYIMIDE
Break Strength	12–35 N/mm (70–200 lbf/in)	12 N/mm (70 lbf/in)
Elongation	20–40%	75%
Dielectric Strength	16–39 kV/mm (400–1000 V/mil)	9500 V (nominal)
Bond Strength	1.05–1.75 N/mm (6.0–10 lbf/in)	1.23–2.80 N/mm (7.0–16 lbf/in)
Temperature Range	-58°C to 232°C (-70°F to 450°F)	-50°C to 232°C (-58°F to 450°F)
Flammability Rating	UL 94 HB UL V-0 available	UL 94 HB
Curing Conditions Temperature Pressure Time	100°C–177°C (212°F–350°F) 210 ± 100 kPa (30 ± 15 psi) 5–15 minutes	120°C (248°F) 120 kPa (17.5 psi) 15 minutes
Post-Cure Treatment	2–4 hours @ 204°C (400°F)	n/a
Thickness	0.38+ mm (15+ mil)	0.13 or 0.18 mm (5.0 or 7.0 mil)
Weight	510–980 g/m ² (15–29 oz/yd ²)	160–370 g/m ² (4.6–11 oz/yd ²)
Color	Numerous options available	Iron oxide red and translucent
Features	Numerous designs available with and without fiberglass fabric lamination	Available in both generic and Kapton branded polyimide
Laminating	Inconel 600 and SS 304	Inconel 600

All metric conversions are approximate.
Typical values should not be used for specification limits.
Additional technical information is available.

Silicone vs. Polyimide

This section outlines the advantages of each substrate option—silicone and polyimide—and outlines the specific design options for each.

ADVANTAGES OF A SILICONE SUBSTRATE	
PRODUCT ADVANTAGES	DESCRIPTION
UL Recognized	UL File E54153
Easy to Fabricate	Convertible with steel rule dies, drag knives, water jet, or hand cutting Composites shaped before cure hold their shape afterwards Uncured rubber acts as its own adhesive
Robust Build	Better handles abrasion and mechanical damage than polyimide
Customizable	Numerous colors and constructions available
Fiberglass Reinforced	Makes material more robust without sacrificing flexibility
Water Resistant	Silicone forms a moisture barrier

Silicone Substrate Design Options

The silicone substrates designed for flexible heaters have several customization options: carrier material, silicone type, and substrate construction.

Carrier

The silicone substrates are available with the following carriers: fiberglass-reinforced fabric of thicknesses 0.013, 0.20, or 0.41 mm (5, 8, or 16 mil); PTFE coated fiberglass release liner; or 0.013 mm (5 mil) PET release liner.

Silicone Type

The different silicones offered differ based on the UL rating. The options are non-UL rated silicone, UL-rated silicone with either 200°C/200°C (392°F/392°F) or 220°C/220°C (428°F/428°F) relative thermal index (RTI), or UL94 V-0 rated silicone.

Constructions

The silicone substrates are offered in several different constructions. On each side of the carrier, there can be cured silicone, uncured silicone, no silicone, or uncured on top of cured silicone.

Silicone vs. Polyimide

ADVANTAGES OF A POLYIMIDE SUBSTRATE	
PRODUCT ADVANTAGES	DESCRIPTION
Quality Engineered	Formulated to eliminate voids, blisters, and bubbles with low/no pick off
Low Out-gassing	Meets ASTM E595 for low outgassing Less out-gassing than the silicone alternative
Very Lightweight	Approximately 50% lighter than the silicone material
Thinner Design	Thicknesses do not exceed 0.18 mm (7 mil)
Faster Response	Thinner design means less time needed for heat transfer to occur

Polyimide Substrate Design Options

Options include choice of polyimide type, product thickness, and laminate.

Polyimide Type

Customers can choose between generic polyimide or DuPont Kapton® polyimide.

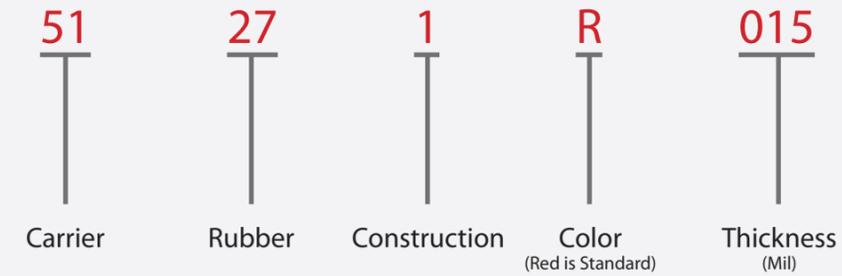
Product Thickness

Two different product thicknesses are offered. Product thickness options are 0.08mm (3 mil), or 0.013mm (5 mil). Polyimide thickness is constant at 0.05mm (2 mil).

Laminate

raPId substrates are available without a laminate or with Inconel 600 Foil.

Product Naming Convention



THICKNESS CODE	TARGET/TOLERANCE (RUBBER = 14, 27, & 98)	TARGET/TOLERANCE (RUBBER = 10)
010	10.0 mil +/- 1.0	10.0 mil +/- 1.5
015	15.0 mil +/- 1.5	15.0 mil +/- 2.0
020	20.0 mil +/- 2.0	20.0 mil +/- 2.5
030	30.0 mil +/- 2.0	30.0 mil +/- 3.0

RUBBER CODE	DESCRIPTION
10	Non-UL
14	RTI = 200°C/200°C
27	RTI = 220°C/220°C
98	UL 94 V-0
C2	raPId Polyimide

CODE	CARRIER
32	5 mil release PET
34	5 mil PTFE film
44	5 mil fiberglass fabric
51	8 mil fiberglass fabric
55	16 mil fiberglass fabric
99	PTFE coated stock
39	Generic Polyimide
40	Kapton® Polyimide

	CONSTRUCTION CODE			
	0	1	6	9
Side 1	Uncured	Uncured	Cured	Uncured on top of cured
Side 2	None	Uncured	Uncured	None

Flexible Heater Product Examples

raPID Polyimide Heaters

The three raPID technology substrates offered by Rogers are presented below. All products are offered with either generic polyimide or DuPont Kapton® polyimide.

TYPICAL APPLICATION	ARLON PRODUCT #	PRODUCT CONSTRUCTION				DIELECTRIC STRENGTH	PLY ADHESION
		SIDE 1	SUBSTRATE	SIDE 2	LAMINATION		
Foil Lamination	40C20N005	Uncured 0.08 mm (3.0 mil) [Clear]	Kapton Polyimide 0.05 mm (2.0 mil)	None	None	9.5 kV	1.6 N/mm (9.0 lbf/in)
Foil Lamination or Wire Encapsulation	40C20R007	Uncured 0.13 mm (5.0 mil) [Red]	Kapton Polyimide 0.05 mm (2.0 mil)	None	None	9.5 kV	2.9 N/mm (17 lbf/in)
Etched Foil Circuit	I40C28N005	Uncured 0.08 mm (3.0 mil) [Clear]	Kapton Polyimide 0.05 mm (2.0 mil)	None	Inconel 600 0.03 mm (1.0 mil)	9.5 kV	1.3 N/mm (7.3 lbf/in)

Flexible Heater Product Examples

Silicone Heaters

Several silicone product examples are listed below. Rogers offers a full range of options including specialty fabrics, silicone rubber compounds, colors, thicknesses, construction, liners and more. Please contact us to discuss your specific requirements.

TYPICAL APPLICATION	ARLON PRODUCT #	PRODUCT CONSTRUCTION				DIELECTRIC STRENGTH	PLY ADHESION
		SIDE 1 SILICONE	SUBSTRATE	SIDE 2 SILICONE	LAMINATION		
Bonding	99270R015	Uncured 0.38 mm (15.0 mil)	None	None	None	19.5 kV	n/a
Bonding	51271R015	Uncured 0.10 mm (4.0 mil)	Fiberglass 0.20 mm (8.0 mil)	Uncured 0.08 mm (3.0 mil)	None	6.0 kV	1.2 N/mm (7.0 lbf/in)
Wire Encapsulation or Foil Lamination	51276R015	Uncured 0.10 mm (4.0 mil)	Fiberglass 0.20 mm (8.0 mil)	Cured 0.08 mm (3.0 mil)	None	6.0 kV	1.1 N/mm (6.0 lbf/in)
Wire Encapsulation	55279R030	Uncured 0.20 mm (8.0 mil) + Cured 0.15 mm (6.0 mil)	Fiberglass 0.41 mm (16 mil)	None	None	9.0 kV	1.1 N/mm (6.0 lbf/in)
Waterproof Substrate	34C36R020	Cured 0.17 mm (6.5 mil)	PTFE 0.13 mm (5.0 mil)	Uncured 0.22 mm (8.5 mil)	None	26.8 kV	0.8 N/mm (4.5 lbf/in)
Etched Foil Circuit	S51278R015	Cured 0.08 mm (3.0 mil)	Fiberglass 0.13 mm (5.0 mil) [Red]	Cured 0.14 mm (5.5 mil)	Stainless Steel Foil 0.05 mm (2.0 mil)	6.0 kV	n/a
Etched Foil Circuit	I51576R015	Cured 0.14 mm (5.5 mil)	Fiberglass 0.20 mm (8 mil)	Cured 0.05 mm (2.0 mil)	Inconel 600 0.03 mm (1.0 mil)	11.5 kV	1.2 N/mm 7.0 lbf/in



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