300C High Temperature Flexible Heaters

Written by: Dave Becker, All Flex

all flex

Flexible Circuits • Heaters • Assemblies

Flexible polyimide heaters are adopted in medical instrumentation products to precisely test tissue and blood samples. Aerospace applications control temperatures of telecommunication space electronics while military computers operate quickly in sub-zero environments and airplanes are designed with heaters that de-ice select wing locations. The list is limited only by engineering imaginations. These thin polyimide film substrates are combined with copper, copper alloys, and other resistive metals. In many ways, the utility offered by a flexible heater sounds strikingly similar to its flexible circuit cousin. Some of advantages of flexible polyimide heaters include:

- Extremely thin and bendable materials conform to multiple planes
- Reduction of weight and volume
- Assembly processes are fool-proofed with precisely dimensioned heater shapes
- Parts are duplicated through repeatable processes and supplied pre-tested by the fabricator
- Added components (temp sensors) monitor and control temperatures within a narrow range

In the flexible heater industry, the push has been to achieve higher and higher performance temperatures. Many suppliers are offering flexible heaters with polyimide and/or silicone rubber materials to provide flexible and bendable heaters. Standard temperature capability for these heaters is to perform continuously and reliably at about 150°C. All Flex has recently developed and introduced a new composite construction that considerably exceeds this temperature. Temperature extremes significantly exceeding this elevation have also been demonstrated. New materials and development of process technology have made this leap forward possible. Test data has shown highly reliable heater performance at 300°C can be achieved in a continuous operating environment. Some of the All Flex test results follow.

Methodology

A 2” x 5” polyimide based test heater was bonded with .002” thick adhesive to a pumice scrubbed and RO water cleaned 30 mil aluminum plate. The heater was placed under power and adjusted to produce a specific test temperature of 300°C which was monitored using an infrared camera. The heater was regularly monitored to assure temperature maintenance and evaluate heater integrity.

Heater image before thermal aging

A 2” x 5” polyimide based test heater was bonded with .002” thick adhesive to a pumice scrubbed and RO water cleaned 30 mil aluminum plate. The heater was placed under power and adjusted to produce a specific test temperature of 300°C which was monitored using an infrared camera. The heater was regularly monitored to assure temperature maintenance and evaluate heater integrity.

The test heater was exposed to a 500 hour thermal bake at 300°C by powering the heater with a power source and monitoring the heater temperature with a Fluke Ti200 IR thermal imaging system. The IR camera was calibrated by adjusting the unit's emissivity setting to match the emissivity of the heater (0.89). The heater emissivity was determined with an AZTek 2000A emissometer. The thermal readings were verified using a second thermal imaging unit (Amprobe IR-720). The heater temperature was routinely checked during the test period and the power source was adjusted as necessary to maintain the test temperature. A visual photo of the heater was taken at the beginning and end of the test. An infrared image of the heater at the end of the test was also taken. Results of the test are shown below.

Test Data Sheet -High Temperature Materials

All Flex

Notes: Heater bonded to 30 mil pumice scrubbed Al plate
Heater bonded to Al Plate with Type A-01 adhesive
Circuit taken directly to 300°C using power supply

Test Construction

Circuit Design

	All Flex P00585-RA111	X
	All Flex P06.5-RA110	

Adhesive Type:

	Type A-01	
	Type B-02	
	Type C-01	
	Type A-01	X

			P00585; Type A-01	
Setting	**Amps**	**Time**	**Ave °C**	**Max °C**
31V	2.7	10:00	298	301
31V	2.7	8:40	296	303
31V	2.7	10:35	297	303
31V	2.7	8:30	298	303
31V	2.7	8:03	297	303
31V	2.7	7:15	297	303
31V	2.7	7:05	297	303
31V	2.7	9:45	295	300
32V	2.8	8:15	298	303
32V	2.7	8:06	300	303
32V	2.8	7:16	298	304
32V	2.8	7:50	298	303
32V	2.8	7:05	298	304
32V	2.8	8:23	305	311
31V	2.7	7:10	301	305
		AVG	298.2	303.4667

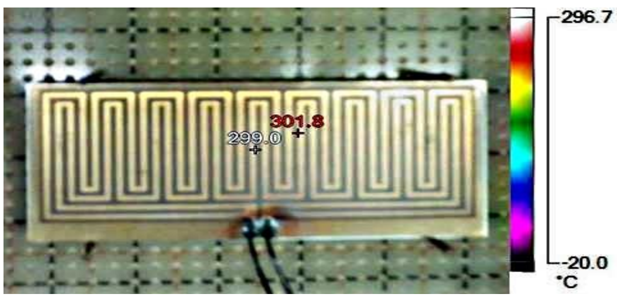
Start Time	End Time
10:00	7:10 AM
0.4166667	0.298611

Elapsed Time

Days	Hours
20.881944	501.1667

After exposure to the elevated temperature, significant darkening of the heater circuit was observed, but no apparent blistering, charring, or loss of function. The welded leads were not potted in a heat resistant compound and consequently the leads were significantly oxidized and the insulation on the wires was burnt back 0.5 inches from the heater surface. However, continuity was not lost during the test cycling.

Visual image after 500hrs @ 300°C



Thermal image after 500hrs @ 300°C

Infrared measured delta temperature front to back surface is in the range of 12°C – 18°C. A thermocouple reading on the back side (plate) states 288°C.

While application specifics always create unique performance requirements, the testing has been able to demonstrate an ability to achieve extended operational temperatures of 300C. Additional testing is underway to further quantify capabilities, limits and future direction as application requirements continue to push flexible heater temperatures to new performance extremes.