Measurements of Imparted Strain in Simulated GLAST Silicon Strip Detectors

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Abstract

This report summarizes measurements made of the strain measured on silicon bonded with 23 & 39 dot patterns to 6061 T6 Aluminum. Nusil® CV 1142-1 Silicone Adhesive was used to bond the silicon to the aluminum substrate. It was observed that the strain transferred to the silicon through the adhesive in both of the dot patterns is very low. Following are the imparted strains taken at different selected temperatures:

~Temp. (C)	23 Dot Pattern	39 Dot Pattern	Bare Silicon	23 Dot compared to bare Si	39 Dot compared to bare Si
59	-277	-261	-281	-4	-20
25	-1	-2	-2	-1	0
0	187	182	186	-1	4
-55	656	626	707	51	81

Note: All readings are in Micro Strains

Test Setup

Uni-axial strain gage of type Vishay CEA-06-250UW-350, lot # R-A58AD826 was used on each test piece (silicon glued to an aluminum substrate). A similar gage from Lot # R-A58AD814 was used on a bare piece of silicon to calculate the strain transferred to the silicon through the Nusil adhesive. The gages were applied in accordance to Vishay Instruction Bulletin B-137-16.
(http://www.measurementsgroup.com/guide/ib/b137/137d.htm).

M-Bond AE-10 was used as an adhesive for gluing the gages.
NUSIL Silicone Technology CV 1142-1 (adhesive) was used to glue the Silicon to the Aluminum substrate.
The dimensions of the silicon test pieces were 89.5 mm^2 x .41 mm thick. The aluminum substrates were ~11 cm^2 x 1 cm thick.
Both the dot patterns consisted of dots approximately 9 mm in diameter and 0.15 mm thick. Thickness of the bond was established by spacers in between the dots to assure consistency.
The gages were soldered as per the techniques stated in Vishay Gage Installation: Soldering Techniques (http://www.measurementsgroup.com/guide/tt/tt609/609intro.htm)

All data acquisition was done with a Vishay Systems 5000 Model 5100 Scanner equipped with a Strain Gage Input Card (Model 5110) and a Thermocouple Input Card (Model 5120), each containing five channels. Two Type 'T' thermocouples were used for measuring the environmental temperature of the detector. "Strain Smart" software was used for measuring the strain.

A Cincinnati Sub-Zero dual stage environmental chamber was used to cycle the test pieces and the reference sample through the desired temperature range.

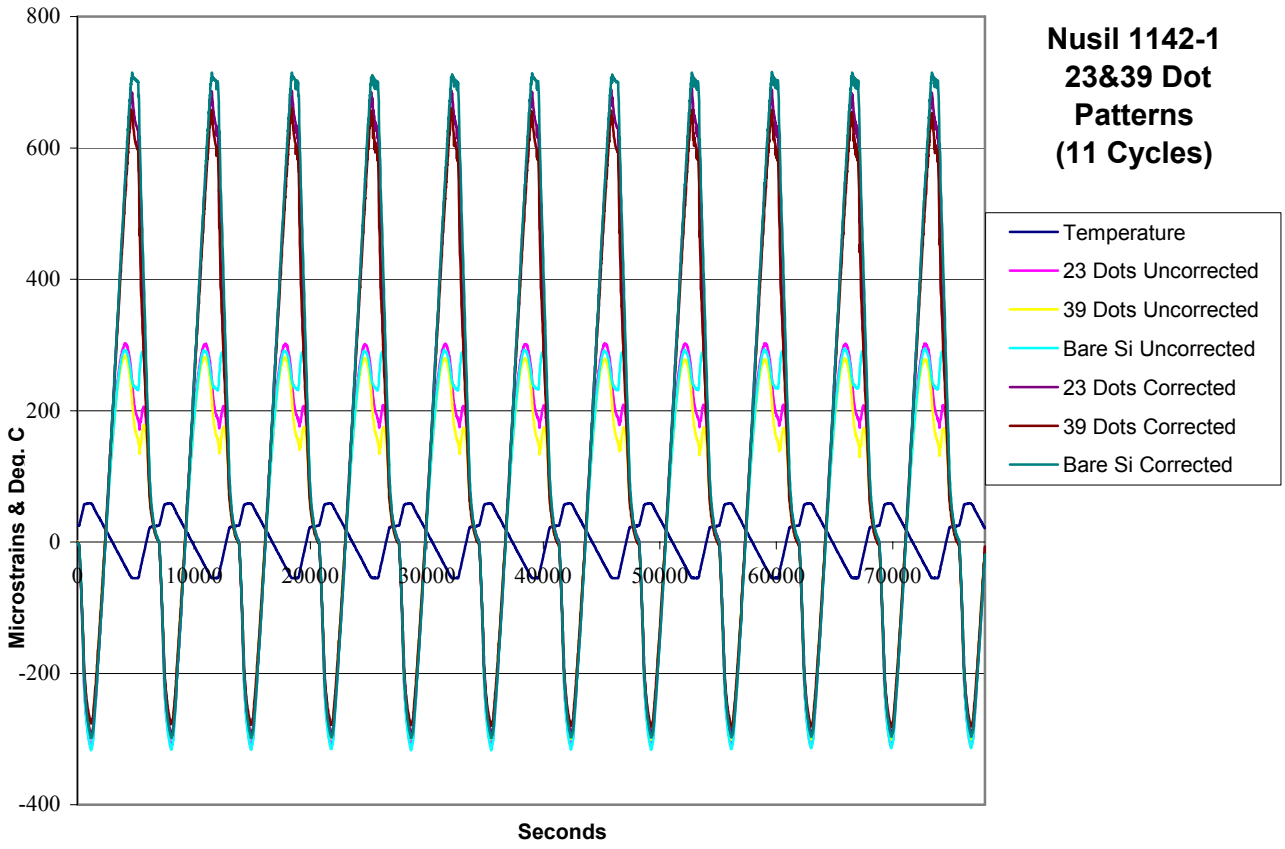
EXPERIMENTATION:

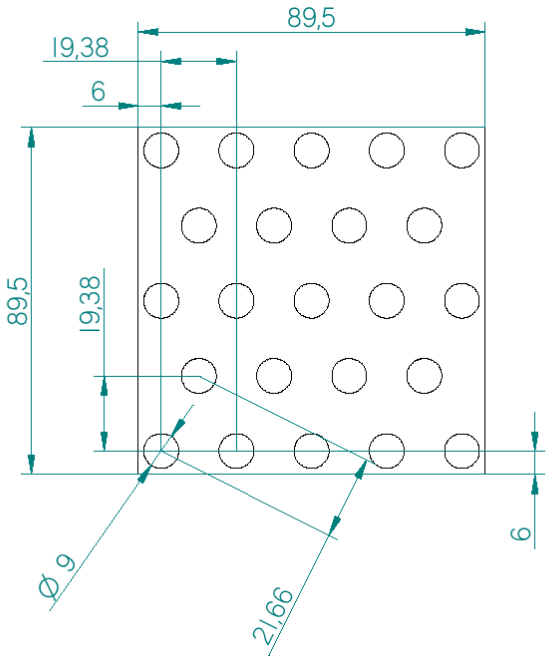
THERMAL CYCLE (25C → 60C → -55C → 25C)

The test was performed for around 22 hours continuously and data was acquired every 20 seconds. During this time period, the test pieces went through 11 thermal cycles.
At the beginning of the cycle, temperature was increased from 25C to 60C at 5 degrees/min. It was then held at this temperature for 10 minutes and then dropped down to –55C at 2 degrees/min. After stabilizing for 10 minutes, the temperature was raised back to 25C at 5 degrees/min, completing one cycle.

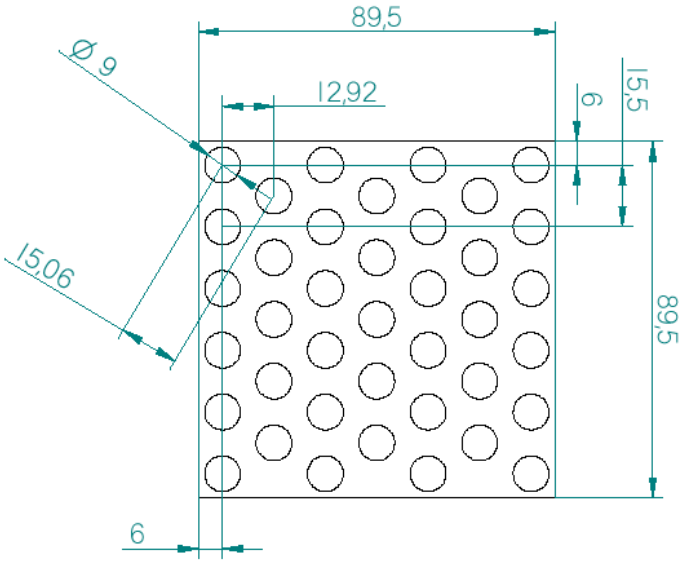
INFERENCES

Aluminum has a much higher CTE (23.6 ppm/C) than silicon (2.6 ppm/C). The amount of strain it imparts to the silicon is very low in this test because of the low modulus of the silicone adhesive.
After the test, the test pieces were examined destructively to check if the silicon was still attached to the substrate. It was observed that the bond was very firm and that the dot size and locations were as expected. No debonding of silicon was observed.





23 Dot Pattern



39 Dot Pattern