Use of Silicone Adhesives for Detector Mounting

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I have spoken with a number of people who are involved in the construction of Silicon Solar Arrays[1]. The construction of these arrays is similar to what we need to do to bond the Silicon Strip Detectors in the LAT. Following are notes relating to these conversations:

Paul Stella[2], formerly of Lockheed Martin, told me that the material used almost universally to bond silicon in these arrays is a single component Silicone adhesive. Ron Dobson[3] spoke about bond thickness. He suggested that the optimum thickness was .005" to .008" and that the size of the glue dot, compressed, should be no larger than .50" to allow proper curing. This type of Silicone requires humidity to cure and is best done at 50% RH. I also spoke to Jari Drlik[4] who is an adhesives expert for Lockheed Martin Missiles and Space Corporation. She reaffirmed his opinion and mentioned that one of the problems with epoxy is that it suffers from mass loss over time. That the epoxy dries up becomes chalky and suffers from gross changes in its elasticity as well as other material properties. Jari referred me to Lowell Yeager[5] as a contact at Lockheed Martin Space Systems for material testing services such as determining moduli and some raw material as well as subassembly level testing capabilities.

I asked about conductive adhesives and was told that the array builders don't use them, they are considered too high resistance for the power requirements of arrays. Paul Stella had an interesting comment about conductive Silicones. He said that the conductivity was great at room temperature but that as the temperature was increased that the silver particles moved apart which resulted in the adhesive changing from a reasonable conductor to a very good insulator at some specific temperature. He said that this effect was not noticed when using the carbon fiber loaded conductive adhesives. If we use Silicone to attach the silicon we should consider carefully how to make the bias connection. The spring contact idea can help in this situation.

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[1] Paul Stella, Ron Dobson, Jari Drlik, Steve Glastner

Paul Stella.msg

[2]

Ron Dobson.msg

[3]

Jari Drlik.msg

[4]

Lowell Yeager.msg

[5]

I also had a discussion with Richard Stallings[6] ,Product Director of Nusil, about CV 2-2646. This is the material that Nusil now suggests for our application of making the bias connection. I talked to Richard about the situation where conductive adhesives 'open' at elevated temperatures. He says that is why the CV 2-2646 material was created. That it uses a combination of fibers and elongated conductive particles that slide against each other as the material warms up keeping the contact quality within the operating range of this material.
The specific recommendations for materials are as follows:

Manufacturer	Product Name
Nusil	CV 1142(1142-1, 7-1142-1, 9-1142)
Dow Corning	DC 93500
General Electric	RTV 566, RTV 568

All of the materials above meet the outgassing specification, can be cured at room temperature and are considered excellent for adhesion to aluminum or silicon with no surface preparation.

Jari Drlik states:
Shear modulus # = tensile modulus# for all elastomers and this value is typically = 100psi -100C
These materials are "methyl Silicones" which uses the Oxime type cure system.[i]
Dimethyl Silicone has two transitions, one is crystallization -100F, glass transition at >100F
The CTE of these materials varies with temperature and is roughly -→-40F to -50F=12.8 1e-5, @+100F 15.5 e-5
At 80F CTE = 12.3 e-5
Poisson's ratio ~.5 for any elastomer,
Lap shear strength tests = tensile shear, assuming cohesive failure, numbers are equal
40lbs / in square is required to get the bond line thickness or some other method like micro-spheres or bond line spacers.
Humidity is very important to the cure of RTV
Width of glue patches must not exceed 13mm to allow full cure in reasonable time.

There has been concern expressed about the possibility of creep in assemblies bonded with low modulus elastomer type adhesive. I asked if they had seen signs of creep in assemblies that had been built with Silicone adhesive and the answer was that in our temperature range Silicone is well within its elastic range and should return repeatedly without suffering from shift. This elasticity remains predictable over time in that the Silicone does not suffer from mass loss de-polymerization and is more likely to remain elastic than epoxy. All of the people that I talked to said "Twenty years ago we thought epoxy was the way to go, but now we all use Silicone."

[i] Oxime type cure system, potentially "discolors" copper alloys per NUSIL Catalog info.


Richard Stallings.msg

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