Conductive Glue under Thermal Cycling

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It has been shown that conductive glues become more resistive with thermal stress. We will test how the conductivity in the glue(s) changes through thermal cycling. It has been decided that the minimum end of life conductivity is 100 ohm-cm. We will make three different types of coupons for these tests: one that has CTE matched pieces, one for non CTE matched pieces, and one with thicker glue. All of the coupons have aluminized silicon bonded to gold pads on kapton using the conductive adhesive; this is the same format that will be used in GLAST. We will also pay close attention to the cleanliness and preparation of both bonding surfaces.

We have been doing research on conductive glues. There Have been many thermal cycling and humidity soaking tests done, typically cycled from –50c to 85c and soaked at 85c with 80% RH. These tests have primarily been done on SnPb materials attached to something else. The tests show that the materials involved are a large factor in how the glues work and we haven't found any tests performed on gold bonded to aluminum. The tests do show that the resistivity increases by around three orders of magnitude with thermal cycling, but the degradation seems to top off. It has also been noted that oxidation of a surface has large effects on the degradation and gold has a much more stable conductivity. The tests also show that humidity allows larger amounts of Ag migration from the glue decreasing the conductivity. It has also been noted that the more contact resistance there is initially the worse the degradation is. The tests that have already been done are exploring the fact that <u>Conductive Adhesives do deteriorate over time.</u>

Test Parameters: (GLAST Thermal Requirements, DRAFT, 3/31/00, Martin Nordby)

1) Temperature ranges
   - Operating range –20c, 35c
   - Survival range –30c, 50c
2) Ramp rate
   - 0.5C/min (proposal)
3) Glue thickness
   - 4 mils and 16 mils
4) # Cycles
   >1000 cycles in operating range
   >100 cycles in survival
   Note: This is the number of test cycles needed for qualification of "end of life" conductivity. For these initial tests we will probably learn a lot from less cycles. We also have decided we need to study the ramp rate we will use because at the current rate 1000 cycles would take 80 days. The worry in increasing the ramp rate is thermal shocking the coupon and causing gradients of temperature within the coupon

Control Considerations:

1) Isolating the glue as the conductive variable. We have to figure out how to get a reliable bond to aluminum without using conductive glue. There are currently two proposals: use a gold plated spring contact with a sufficient force to make the contact, use a normal glue to attach a gold plated connector to the aluminum. We can wire bond from the aluminum to the gold and then solder a wire onto the gold contact. The kapton has pads that we will be able to solder to. The resistance of the glue is given by (Resistance = Volume Resistivity * Length / Area). For a typical silver filled epoxy the volume resistivity is 10^-3 ohms per meter through 10^-5, for a carbon filled epoxy it is around 10 ohms per meter. For a 1 cm square 4 mils thick it gives

@10^-6 ohms and 1 ohm respectively. This then raises the problem that if we are using a silver filled epoxy we will be measuring a small change in a very small resistance. Although our Keithley is capable of this measurement we must explore how to protect our data from the effects of leakage current in the cables and other similar effects that could obscure our data.

2) Eliminating effects of the adherends mismatched CTEs. Induced stress due to material CTE mismatch probably will effect our measurement. Since we cannot simulate the actual GLAST tray CTE we propose initial tests with CTE matched pieces. Although aluminized silicon and kapton have different CTEs, we believe that by rigidly gluing the kapton to a piece of silicon we will be matching the CTEs.

The Three Test pieces:

1) CTE matched pieces (4mils thick). We will attempt to match the CTE of the aluminized silicon and the kapton. The aluminized silicon has such a small amount of aluminum that we can essentially say that the silicon's CTE is the CTE of the two together. If we then take the kapton and glue it to silicon using nonconductive glue we will make the silicon and kapton act as one and its CTE will be the CTE of silicon. This gives us matched CTEs.
2) CTE unmatched pieces (4 mils thick). We will take our aluminized silicon and glue a piece of kapton on to it.
3) Thick glue (16 mils thick). This will use CTE matched pieces but we will use a large thickness of conductive glue.

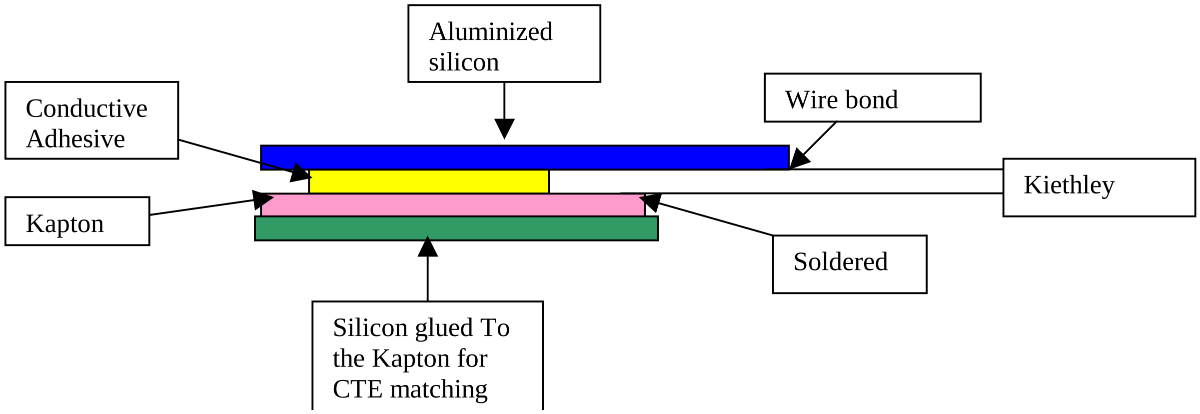
* We will use clean parts that have been stored in a nitrogen cabinet. Surface preparation may be needed in the future, but the type and procedure will have to be identified.

Test Procedure:

1) We will initially build our coupons using the adhesive(s) picked by SLAC.
2) Our tests will be done by first measuring the change of conductivity in the operating range, then we will push it into the survival range. We can only constantly measure one coupon's conductivity for each source measure unit we use, so we will manually check multiple coupons over intervals of cycles (probably one measurement every 5 cycles)
3) We will use a Sun environmental chamber and a Keithley Source Measure Unit to execute the experiment. (This raises the problem the Sun EC127 has a temperature limit of –30c until we successfully install liquid nitrogen cooling, this will allow lower the limit to @ -60c. Kiethley precision =10^-9 ohms)

Goals:

We have two main goals: determine the properties of the conductive glue, and gain insights on other tests that might be needed.



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