Technical Note – TN-2
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Installation of Semiconductor Strain Gages

Introduction

These instructions establish the procedures for installing Piezo-Metrics semiconductor strain gages to steel and titanium surfaces.[1]

Recommended Equipment

- Tweezers
- Oven capable of reaching 350°F (177°C)
- Hot Plate
- Microscope, 10 to 40X
- X-Acto Knife
- No. 000 sable brush
- Glass slide
- Dental pick
- Epoxylite 6203FF
- Acetone, chemically pure
- Antex Model G/3U 18W soldering iron or equivalent
- Antex 6-NS soldering tip or equivalent
- Koki ECO+PLUS SO3X7CA solder, 220 C melting point or equivalent
- SRA Rosin Paste, Flux #135 or equivalent

Epoxy

Piezo-Metrics recommends Epoxylite™ 6203FF epoxy for affixing the gages to the metal surfaces. This is a high temperature, extreme range adhesive, “stable” to +500°F (260°C) for short durations. It is a two-part epoxy, consisting of Biphenol A with PDMA as a catalyst.

Epoxy lite 6203FF is available as a premixed and frozen adhesive and this form is ideal for gaging.

[1] **Important Note**
The following information is provided strictly as a general guideline for installing Piezo-Metrics semiconductor strain gages to steel and titanium surfaces. Please be aware that the installation of semiconductor strain gages is a complex process and requires considerable experience and expertise.
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The frozen epoxy must be allowed to warm to room temperature, 60°F - 80°F (16°C – 27°C), for about 15 minutes prior to opening the tube. Before opening the tube, wipe the tube off with a clean, dry, lint free cloth. Any moisture that comes in contact with the epoxy will cause the bonding properties of the epoxy to degenerate.

Once opened, the ambient useful life for bonding gages is 3 hours. If heated to 150°F (66°C), the useful life for bonding is five (5) minutes.

Surface Preparation

1. Sandblast or abrade surface with 600 grit wet-dry sandpaper the surfaces that are to be gaged.
2. Chemically clean the surfaces that are to be gaged with acetone. Dry thoroughly and verify that there is no lint or other residue left on the surface to be gaged. Repeat as necessary, using a microscope to verify that there is no residue left.

Base Coat Application

1. Set the hot plate at 110°F to 200°F (43°C to 93°C).
2 Place the part, to be gaged, into an oven set at 200°F ± 40°F (93°C ± 22°C) for 1 hour.
3. Remove the part from the oven and place it on the hot plate. It may be necessary to hold the part to be gaged with a clamp, vise, etc.
4. Apply a thin coat of epoxy onto the surface to be gaged. Use either a No. 000 brush or dental pick.
5. Brush the epoxy to an even coat. Avoid excessive brushing. The base coat should be between 0.4 and 0.7 mils thick.
6. Cure the base coat for 15 to 30 minutes at 250°F ± 10°F (121°C ± 6°C).

Strain Gage Preparation

1. Pick up the strain gage up with the tweezers by one lead positioning the tweezer tips approximately 1/32” (0.8 mm) from the strain gage terminal end.
2. Straighten the gold lead.
3. Trim the gold lead with an X-Acto Knife to a maximum length of 0.4” (10 mm) if necessary.
4. Hold the gage with a pair of tweezers and slide a dental pick under the gage wire. Carefully bend the lead so that it is at a right angle with the strain gage.
5. The lead should be straight and bent near the pad.
6. The lead wires should be at right angles to the centerline of the strain gage starting at approximately 1/32” (0.8 mm) from the strain gage terminal end.

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Strain Gage Installation

Strain gages are to be installed only on flat, blemish-free areas which have been base-coated.

1. Mark centerlines on the part where the strain gages will be installed. The centerlines will be used to accurately position the strain gage on the part.
2. Heat the part to be gaged to approximately 150°F (66°C). If the part requires a holding fixture, such as a vise or a clamp, mount the part on the fixture before heating the part.
3. Using the tweezers, pick up the gage by squeezing the tips on the gold lead near the strain gage/gold lead wire bond.
4. Apply a thin coat of epoxy to the bottom of the gage by dipping it into a small puddle of Epoxylite 6203FF. Orient the gage on the part as necessary.
5. Using a microscope, check to ensure that a small fillet of epoxy has formed around the periphery of the gage once it has been dropped into the correct position.
6. Apply a coat of epoxy to all uncoated surface(s) over which the gage wire will be routed and to the area(s) where the solder tabs are to be located.
7. Cure the Epoxylite 6203FF for 1 hour at 350°F (177°C).

MST Solder Tabs Installation

Instrumentation cabling cannot be soldered directly to the semiconductor strain gage. An intermediate Piezo-Metrics solder terminal called an MST is used as an interface to solder the gold leads and the instrumentation leads. See Figure 1.

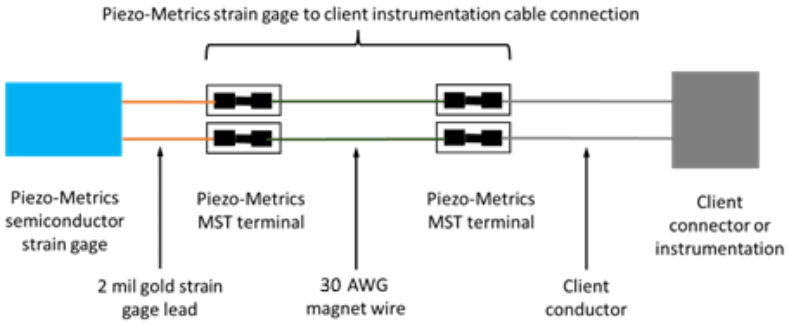

Figure 1 – Interconnection between semiconductor strain gage and client instrumentation

1. Apply a small amount of Epoxylite 6203FF epoxy on the areas where the MST solder tabs will be located.
2. Position the MST solder tabs as desired.
3. Cure the epoxy for 2 hours ± 30 minutes at 250°F ± 10°F (121°C ± 6°C).

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Soldering Gold Leads

The gold leads of a semiconductor strain gage will evaporate if too much heat is applied during the soldering process. To successfully solder the gold leads to creating a strain gage circuit, the heat-time profile applied to the solder must be carefully controlled so that the heat reaching the gold wire is limited. A lower melting temperature solder combined with a low wattage soldering iron must be used.

1. Apply a layer SRA Rosin Paste on the MST terminal pads.
2. Tin the MST pads with a small bump of Koki ECO+PLUS SO3X7CA solder using an Antex soldering iron equipped with an Antex 6-NS soldering tip.
3. Bend the gold lead so that it forms a small S-shape to act as a strain relief.
4. Position the end of the gold lead on one end of the solder bump ensuring there is physical contact between the solder bump and the gold lead.
5. Apply the solder iron tip to the opposite end of the solder bump.
6. As soon as the solder bump starts to melt, quickly remove the soldering iron tip.
7. The solder should flow around the gold lead where it touches the solder bump without melting it.
8. If there is a bit too much heat, the solder will flow up the gold lead without melting it.
9. If there is too much heat, the gold wire will melt where it touches the solder.
10. If the gold lead is melted, stretch out the S-shape in the gold lead and try again.

Inspection

The following criteria are suggested for inspecting the installation of the gages and gold lead soldering after gaging has been completed.

1. Verify that all gages have a fillet of epoxy around the sides of each gage.
2. Verify that all gages are oriented properly according to the applicable drawing(s).
3. Verify there are no electrical shorts between the gold leads and the metallic structure.
4. Verify, if possible, the insulation resistance between the semiconductor strain gage and the ground of the metallic structure. The insulation resistance must be greater than 50MΩ at 50 VDC.

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Professional Semiconductor Strain Gage Installation Services

Piezo-Metrics is not only the leader in semiconductor strain gage solutions, but we are also known worldwide for our expertise in installing semiconductor strain gages on components of all shapes, sizes, and materials. Each of our trained technicians is experienced in component handling, briefed on project confidentiality, and up to date on application methods. A large majority of our Gaging Technicians have 25+ years of gaging experience at Piezo-Metrics.

Piezo-Metrics routinely gages components for:

- Torque, load, and bending applications.
- High and low temperature applications.
- Medical, aeronautical, and industrial applications
- Custom designed components that require multiple gage sets.
- Harsh conditions, including submerged sensors.
- Components requiring Quarter, Half-Bridge, and Full-Bridge Configurations.

Additional Information

For more information about temperature compensation, please visit the Piezo-Metrics website at www.piezo-metrics.com and enter questions into the Customer Service Agent. Questions can be similar to:

‘tell me more about gaging services’

‘tell me more about soldering gold wires’

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