Installation Verification

Zero-shift and zero-drift in the resistance of strain gages can arise from a number of sources, including the gage installation itself. This series describes the necessary steps for the verification of strain gage installations to ensure stability.

AFTER BONDING

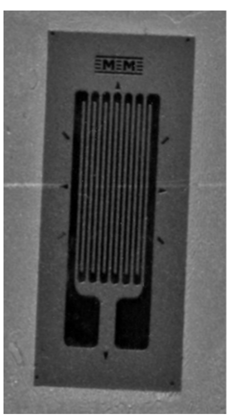
A recommended checklist follows for inspection of installations prior to both leadwire attachment and application of protective coatings. These, by necessity, are limited to visual inspections. Magnification is helpful when dealing with small gages.

Adhesive Uncured

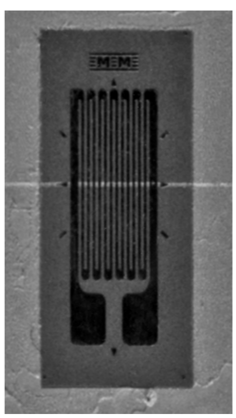
Use a DPR-1 Dental Probe to check the exposed adhesive on the specimen surface beside the gage backing after bonding. If adhesive is soft or rubber-like, either complete the cure (if possible) or replace the installation.

Gage Misaligned

Visually inspect to ensure that the alignment marks on the gage are in the desired orientation. Resulting errors are discussed in Micro-Measurements Tech Note TN-511, Errors Due to Misalignment of Strain Gages.



Misaligned



Aligned

Backing Unbonded

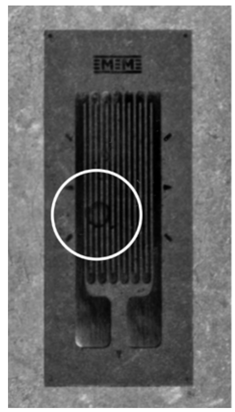
If visibly obvious, gage should be replaced. If in doubt, recheck electrically for zero-return and stability under load after leadwire connections have been made.

Grid Wrinkled or Creased

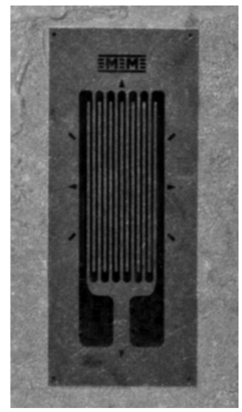
Installer must judge whether caused by normal undulation of adhesive or by mishandling during bonding. If obviously wrinkled or creased, the installation should be replaced.

Bubbles

Usually a concern only when directly under gage grid. If bubble area is small in comparison to grid, check for zero-return and stability under load when electrical connections have been made.



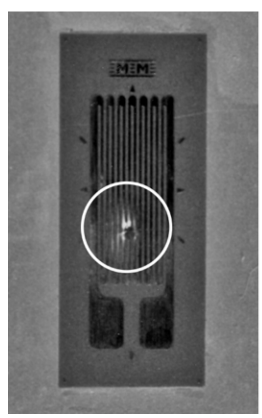
Unacceptable



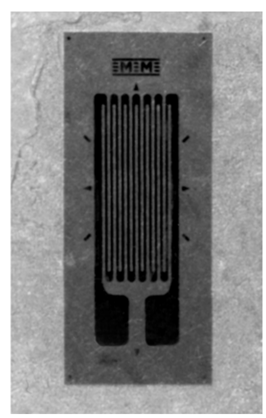
Bubble-free

Bumps

Usually caused by entrapped foreign matter, undissolved crystals of adhesive resin, or filler. May reduce fatigue endurance. Usually a concern only when directly under gage grid. If particle is small in comparison to grid, check for zero-return when electrically connected.



Unacceptable



Bump-free

Residual Tape

Adhesive tapes (and their mastics) used during installation will interfere with environmental protection if not removed.Rosin Solvent may be helpful in removing residual pieces from the gage and specimen.

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Adhesive Layer Uneven

Usually caused by uneven clamping pressure, uneven "gluelines" have a varying color density when viewed through the gage backing. May affect strain transmission, thermal output, and magnitude of errors due to the location of the grid above the specimen surface during bending. Regaging is recommended when pronounced.

Adhesive flow

The adhesive must be present under the entire grid but should not flow between the top surface of the gage and the transfer tape and/or pressure pad. Check for adhesive on solder tabs and terminals that will interfere with soldering.

Discoloration

Unusual darkening of backing or solder tabs may indicate excessive curing temperatures. If soldering is difficult, clean tabs with a soft (usually "pink") pencil eraser. (After protecting the gage grid with drafting tape, stroke the tabs away from the tape. Avoid side-to-side or back-and-forth motions.) Check thermal output and zero-return after electrical connections are made.

Gage Identification

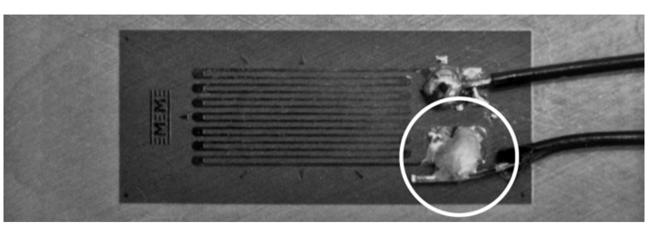
Good practice requires that each gage be identified for reference to the engineering data supplied with the gage. Serialize at the gage site, or prepare a diagram showing gage locations and identification.

AFTER LEADWIRE ATTACHMENT

The following checklist gives the recommended inspections immediately after the completion of leadwire attachment, but prior to the application of a protective coating.

Cold Solder Joints

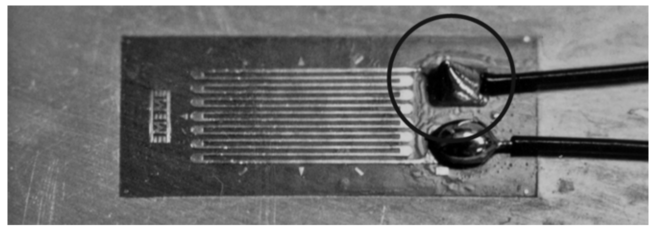
Caused by failure of the entire solder joint to reach the proper soldering temperature, leadwire movement during soldering, or insufficient flux. Solder may not "wet" the leadwire and solder tabs on the strain gage or terminal strip. Cold joints are characterized by an uneven, "flaky" appearance and poor solder flow.



Cold Solder Joint

Solder Peaks

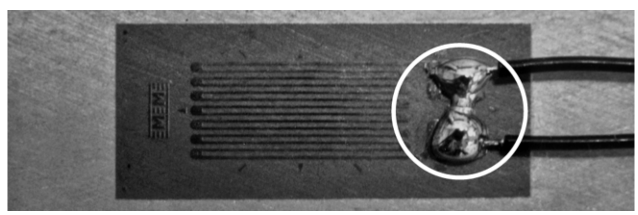
Sharp peaks of solder are usually the result of insufficient flux (use of solder without flux, loss of flux due to excessive soldering temperature, or failure to remove rosin-core solder wire and soldering iron tip from the solder joint simultaneously). Peaks may interfere with flux removal and environmental protection. Large solder masses of any shape are undesirable in tests involving high acceleration or deceleration.



Solder Peak

Solder bridges

Solder tabs are often closely spaced. Care must be taken to ensure that solder joints or excessively long leadwire strands do not form an electrical connection between tabs. A visual inspection is usually adequate. However, an electrical resistance check is recommended if any doubt exists.



Solder Bridge

Wiring Errors

Be certain that all leadwires are connected to their intended circuit locations. Wire markers and color coding are helpful. Electrical verification of connections is recommended for installations with long runs or large bundles of leads.

Installed Resistance

A properly installed strain gage will usually retain a nominal grid resistance within the tolerance shown on the Engineering Data Sheet supplied with it. (Gages installed on a small radius or with a heat-curing adhesive may exceed these limits.) The Model 1300 Gage Installation Tester is an ideal instrument for verifying the deviation of installed resistance (sum of gage grid and leadwire resistances) from the nominal value.

Residual Flux

Visually inspect for flux residue after cleaning with rosin solvent. When cleaning solvents have evaporated, the insulation resistance (leakage) between the gage grid and specimen (if electrically conductive) should be at least

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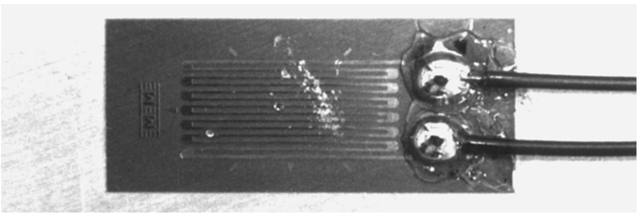
10,000 megohms. *Caution: Always use a megohm meter, like that incorporated into the Model 1300, that applies a test voltage of less than 100Vdc.*



Residual flux

Residual Moisture

Condensation and other forms of moisture may also affect insulation resistance. Dry the installation with warm air and recheck resistance as previously described just prior to the application of any environmental protection.

Zero Return

Connect the installation to a strain indicator and zero-balance. If possible, load the specimen to produce a strain of about the same magnitude expected in the test and unload immediately. The reading should return to within ±5 microstrain of zero. If loading is impractical, protect the gage grid with drafting tape and gently press the grid with a soft (usually pink) rubber eraser. Poor zero return may indicate bubbles, inclusions, or unbonded areas in the adhesive layer under the grid.

Stability

A strain gage subjected to a static strain over a period of time should yield an indicated strain that is stable within a few microstrain. Unexplained changes in indicated strain while the test specimen is under a static load may also be due to bubbles, inclusions, or unbonded areas.

AFTER ENVIRONMENTAL PROTECTION

Circuit Resistance

A repeat check of the resistance of the gage grid and leadwires will ensure that no short circuit, open circuit, or unintentional grounding has developed during installation of the protection system.

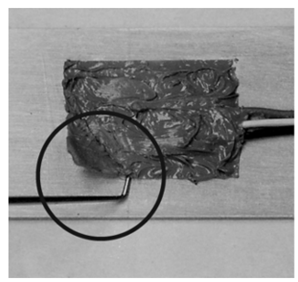
Insulation Resistance

Any moisture or residual flux trapped under the environmental protection may affect the insulation resistance (leakage) between the gage grid and specimen (if electrically conductive). Inappropriate or incorrectly installed coatings may also produce similar undesirable effects. A megohm meter should be used to ensure that the leakage resistance is at least 10 000 megohms (and preferably 20 000 megohms or more). For this test, always use a megohm meter, like that incorporated into the Model 1300 Gage Installation Tester, that applies a test voltage of less than 100 Vdc to avoid damage to the installed gage.

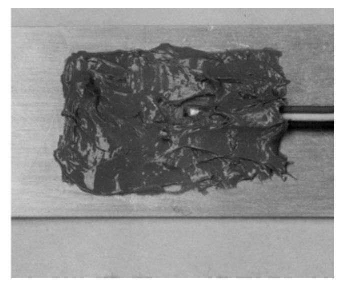
If the insulation resistance is low, the protective coating should be removed and the installation carefully cleaned and dried. Check the resistance again before replacing the coating. If the coating system requires a supplementary insulation over unencapsulated grids and leadwire connections, be sure it is in place. Some coatings contain solvents which must evaporate before an acceptable insulation resistance is obtained.

Visual Checks

Use STW-1 Tweezers or a DPR-1 Dental Probe to locate any unbonded areas between the specimen surface and the environmental protection. Make certain that any holes or voids in the coating are not deep enough to compromise the environmental protection system. Look for uncured areas which may indicate incomplete mixing or curing. Remove coating and apply again if any doubt exists regarding the integrity of the protection system.



Unbonded Coating



Coating Void

Leadwire Anchoring

Leadwires should be held firmly in place for those coatings which harden or cure. Any motion during these processes may produce "tunnels" between the coating and leadwire through which moisture and contaminates can invade the gage installation. (This is particularly true for M-Coat W-1 microcrystalline wax.) Visual inspection of the leadwire entry into the protective coating will reveal the presence of any separation between them.

Unanchored Cable

Anchored Cable

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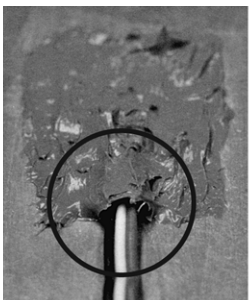
Reinforcing Effects

The extent of reinforcement produced by the protective coating depends upon the dimensions and mechanical properties of the specimen, as well as the protection system itself. While the stiffening effect is often negligible, specimens having thin sections or those made of low-modulus materials warrant special attention. The relative magnitude of the effect on measurement data often can be determined by applying a small preload to the specimen both before and after installation of the environmental protection. If preloads are not permitted, a similarly sized specimen of the same material can be used to make an estimation of the extent of reduction in indicated strain under similar loading conditions.



Tunnel

No Tunnel

Viscoelastic Effects

Most coatings behave in a viscoelastic manner under load and produce reinforcing effects that, in time, approach zero. Conversely, when long-standing loads are removed, reinforcements that are opposite in sign but equal in magnitude to the initial effects are produced. These, too, will diminish with time. If either of these coating-related, viscoelastic effects on the indicated strains are unacceptable in a particular application, an alternate method of environmental protection must be sought.

With the exception of encapsulated gages used in immediate, short-term indoor tests, every strain gage installation should be protected by an appropriate environmental protection system. Properly selected and applied, Micro-Measurements protective coating systems will enhance the quality of your strain measurements by protecting gage installations against chemical attack, mechanical abuse, and electrical malfunctions.

Most gage installations will exhibit none of these faults if the installation techniques outlined in Micro-Measure- ments instructional materials and training programs are followed. However, field applications made in harsh environments, or even laboratory installations with difficult gage locations on the test specimen, warrant special attention. If you have any questions concerning your particular applications, our Applications Engineering Department will be pleased to assist you in establishing a program for verifying the integrity of strain gage installations.