WORCESTER POLYTECHNIC INSTITUTE

MECHANICAL ENGINEERING DEPARTMENT

Engineering Experimentation
ME-3901, D'2012

Laboratory #3: Part 2

General information

Office hours

Instructors: **Cosme Furlong**

Office: HL-151

Everyday:

9:00 to 9:50 am

Christopher Scarpino

Office: HL-153

During laboratory sessions

Teaching Assistants: **During laboratory sessions**

General information

Please refer to handout:
"Laboratory 3: Strain Measurements"

Make sure to install strain gages in three soda cans (same brand). Installations must be suitable for the measurement of tangential (Hoop) strains.

Objectives

The objectives of this laboratory are to:

- Perform measurements of internal pressure in a thin-walled tank by measurements of mechanical strains;
- Perform uncertainty analysis of measured internal pressures with respect to parameters involved;
- Identify, in order of importance, percentage contribution of all uncertainties to the overall uncertainty in pressure measurements;

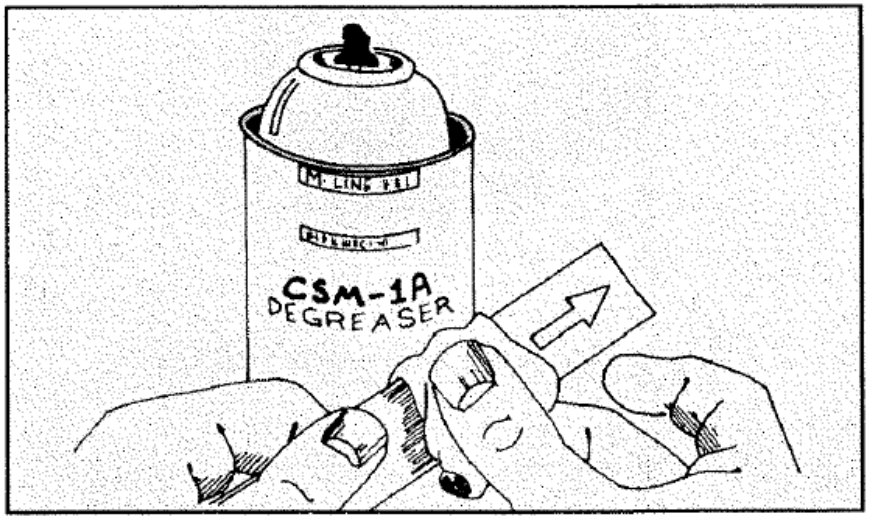
Installation of strain gages

Material needed (modify as necessary):

- Set of strain gages
- Sand paper
- Degreaser/alcohol, conditioner, neutralizer solutions
- Cotton balls & swabs
- One-side sticky tape
- Adhesive
- Low-impedance strain gage wire (≈ 15 ")
- Soldering material
- "Soda cans"

Installation of strain gages: degreasing

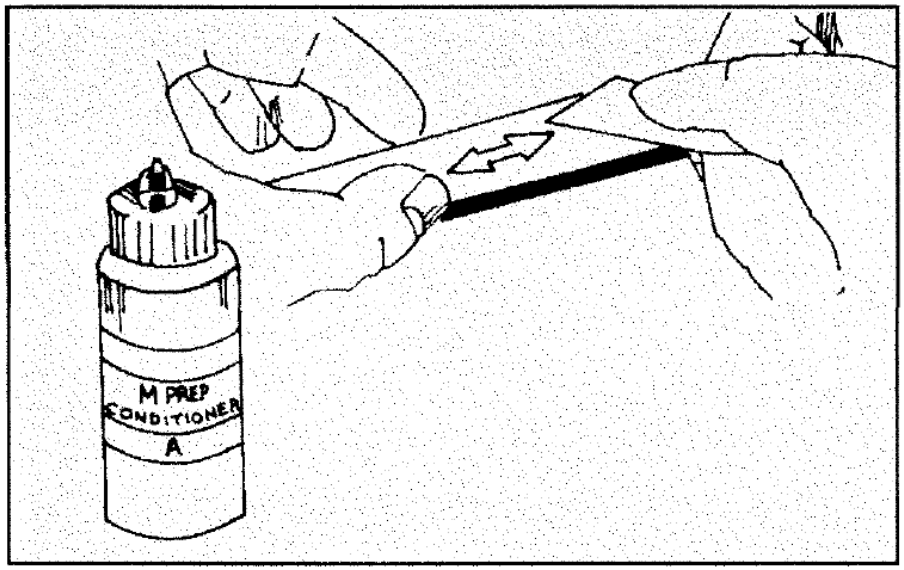
(Alcohol also works well)



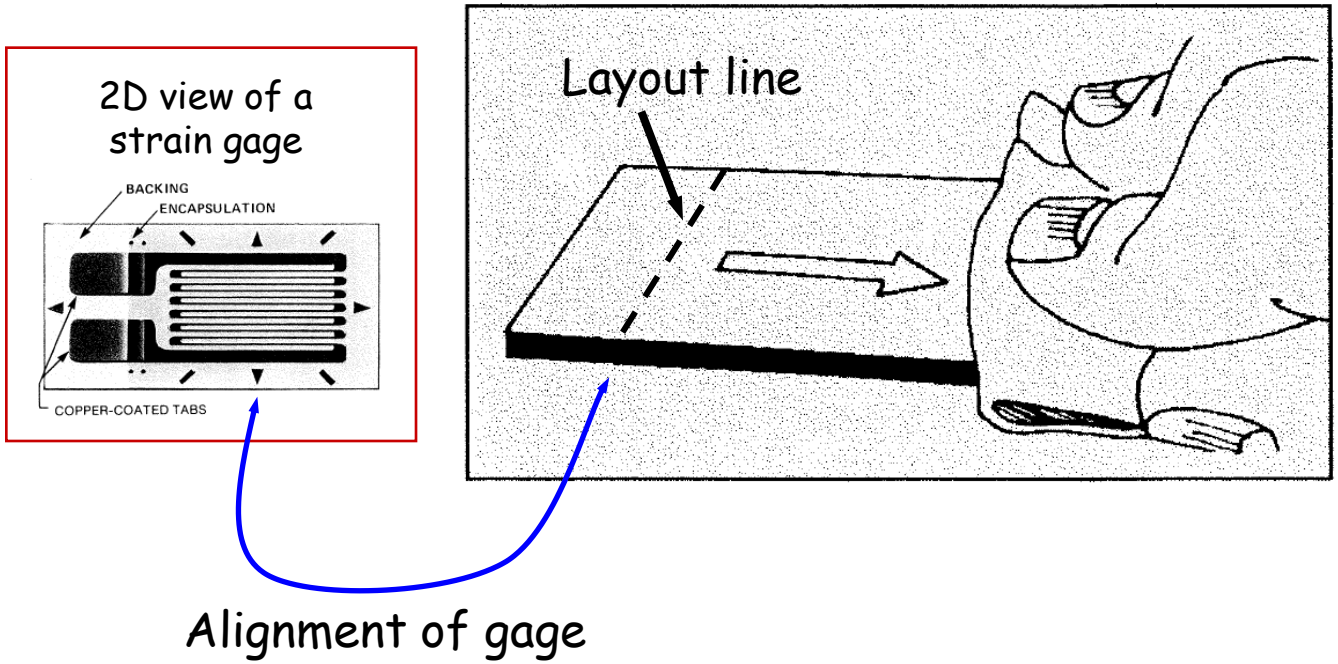
Degreasing is performed to remove oils, greases, organic contaminants, and soluble chemical residues. Degreasing should *always* be the first operation.

Installation of strain gages:
surface abrading w/conditioner

The surface is abraded to remove any loosely bonded adherents (scale, rust, paint, coatings, oxides, etc.), and to develop a surface texture suitable for bonding. For rough or coarse surfaces it may be necessary to start with a grinder, disc sander, or file; but, for most specimens a suitable surface can be produced with only silicon-carbide paper of the appropriate grit.

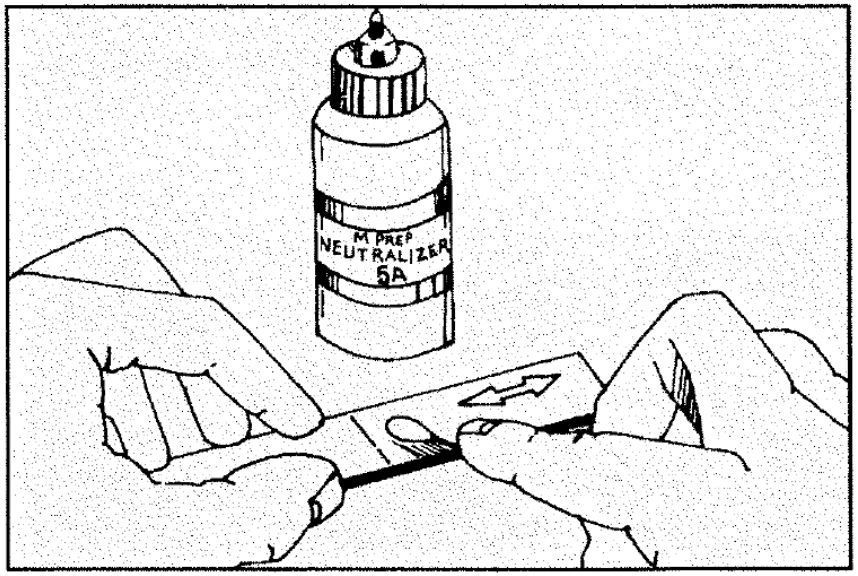


Installation of strain gages: mark layout lines



Installation of strain gages: neutralizer

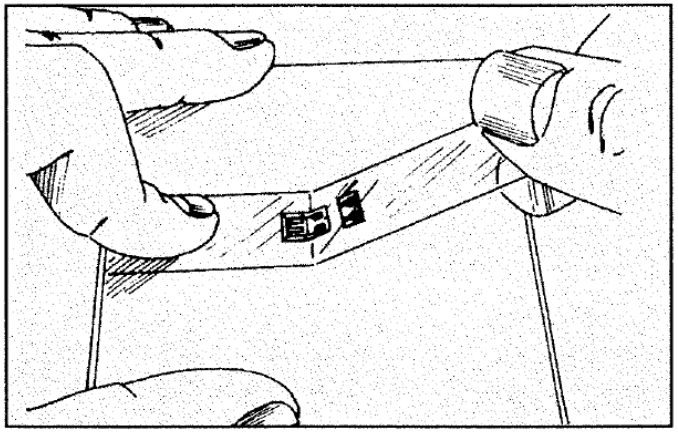
(Alcohol also works well)



Installation of strain gages: mount on tape and align

(Make sure to use the correct side of the gage: observe soldering terminals)

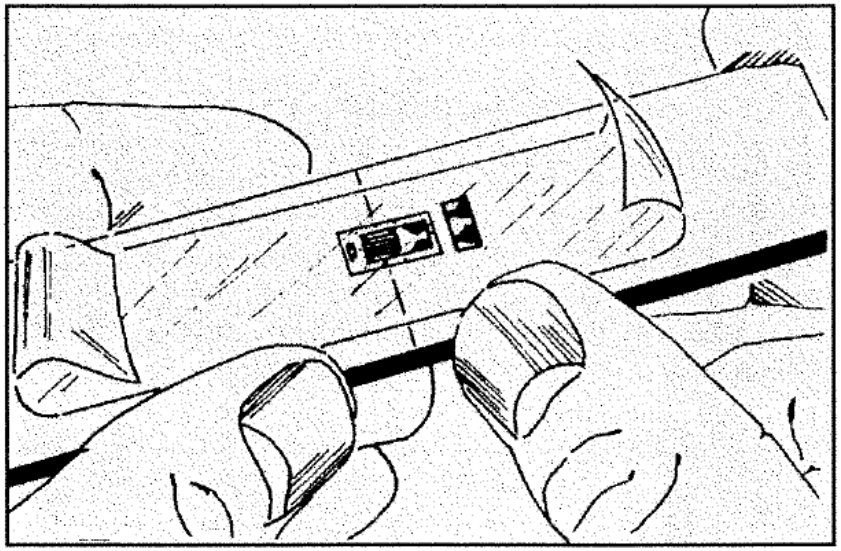
Remove the strain gage from its transparent envelope by grasping the edge of the gage backing with tweezers, and place on a chemically clean glass plate (or empty gage box) with the bonding side of the gage down. Place the appropriate terminals (if any) next to the strain gage solder tabs, leaving a space of approximately 1/16 in *(1.5 mm)* between the gage backing and terminal.



Using a 4-to-6-in *(100-to-150-mm)* length of *M-LINE* PCT-2A cellophane tape, anchor one end of the tape to the glass plate behind the gage and terminals. Pick the gage and terminals up by carefully lifting the tape at a shallow angle (30 to 45 degrees to the glass plate) until the tape comes free with the gage and terminal attached. (The shallow angle is important to avoid over-stressing the gage and causing permanent resistance changes.) **Caution: Some tapes may contaminate the bonding surface or react with the bonding adhesive. Use only tapes certified for strain gage installations.**

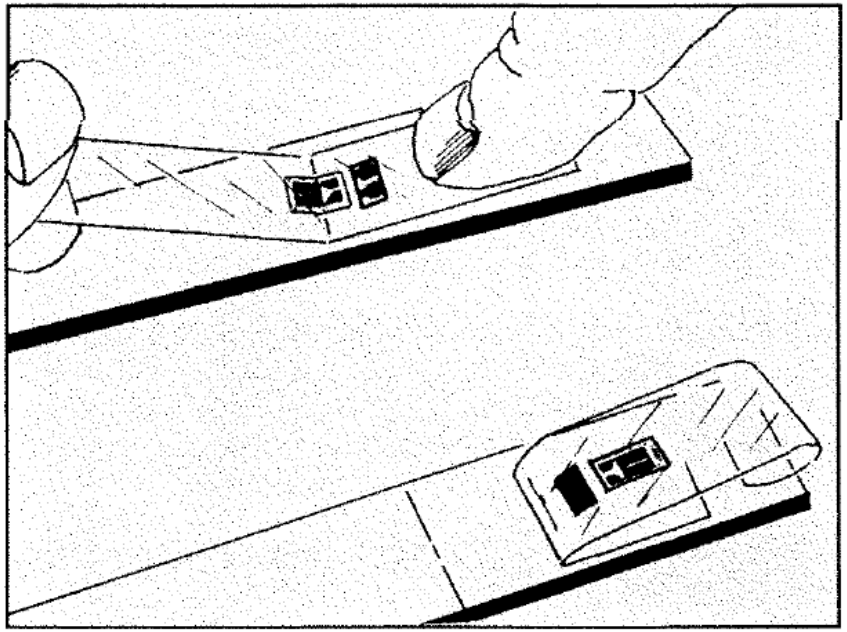
Installation of strain gages: position/align the gage

The strain gage is now prepared for positioning on the test specimen. Position the gage/tape assembly so the triangle alignment marks on the gage are over the layout lines on the specimen. Holding the tape at a shallow angle, wipe the assembly onto the specimen surface. If the assembly is misaligned, lift the tape again at a shallow angle until the assembly is free of the specimen. Reposition and wipe the assembly again with a shallow angle.



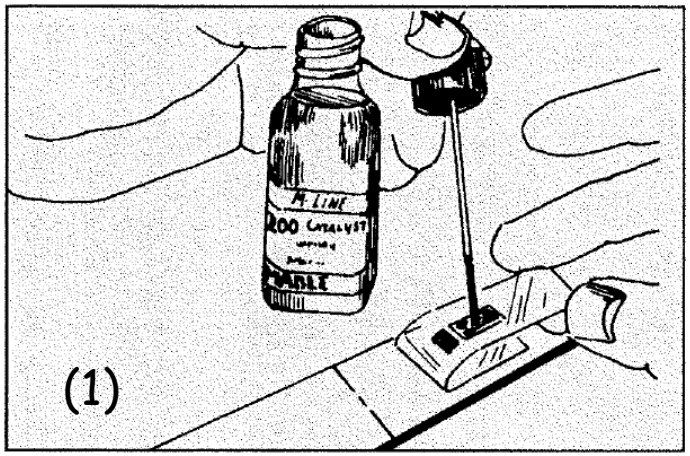
Installation of strain gages: lift tape

(Prior to applying adhesive)

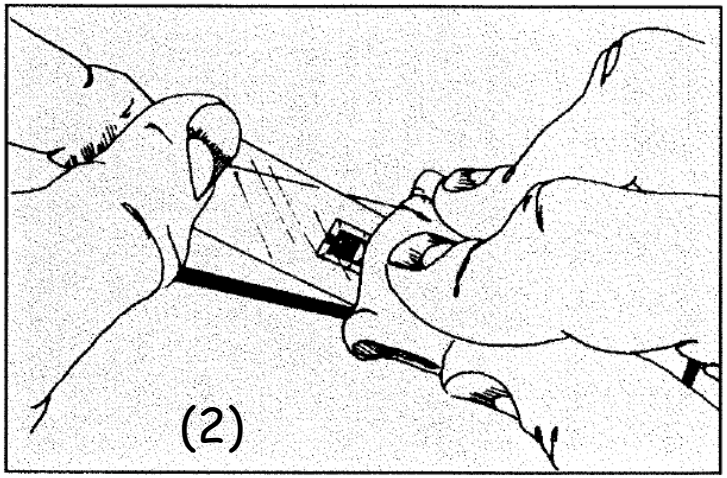


In preparation for applying the adhesive, lift the end of the tape opposite the solder tabs at a shallow angle until the gage and terminal are free of the specimen. Tack the loose end of the tape under and press to the surface so the gage lies flat with the bonding side exposed.

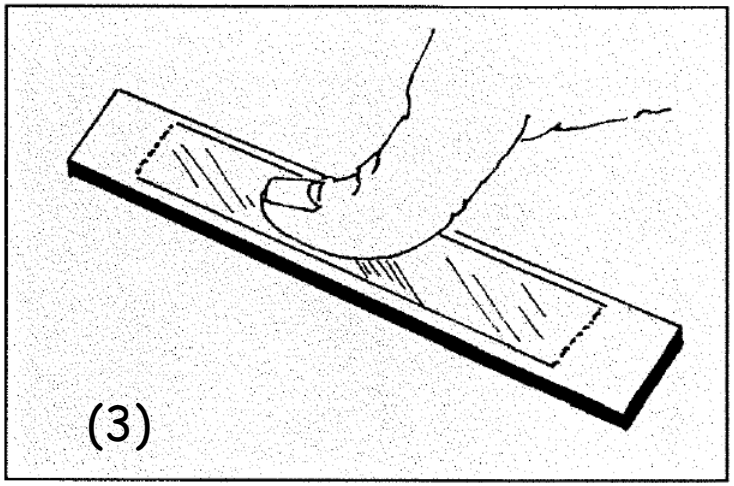
Installation of strain gages: apply adhesive and attach



Holding the tape slightly taut and beginning from the tab end of the gage, slowly and *firmly* make a single wiping stroke over the gage/tape assembly with a clean gauze sponge to bring the gage back down over the alignment marks on the specimen. Release the tape.



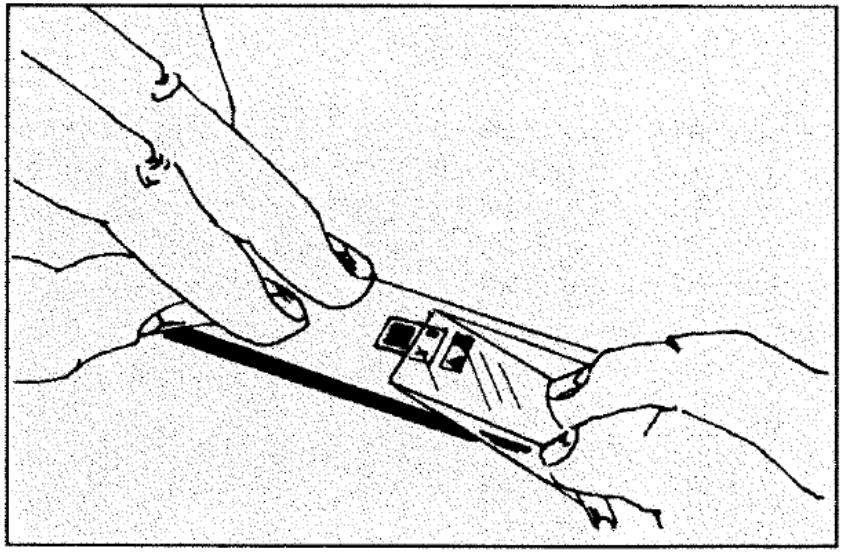
Immediately upon completion of the above step, *discard the gauze* and apply firm thumb pressure to the gage and terminal area. This pressure should be held for at least one minute. Wait two minutes before the next step (tape removal).



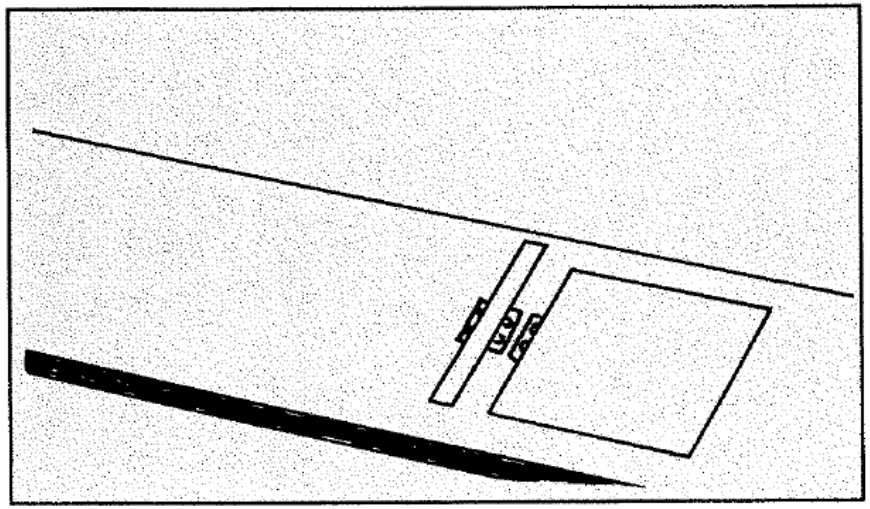
Installation of strain gages: remove tape

(After this operation, carefully clean gage **terminals** with alcohol and a cotton swab)

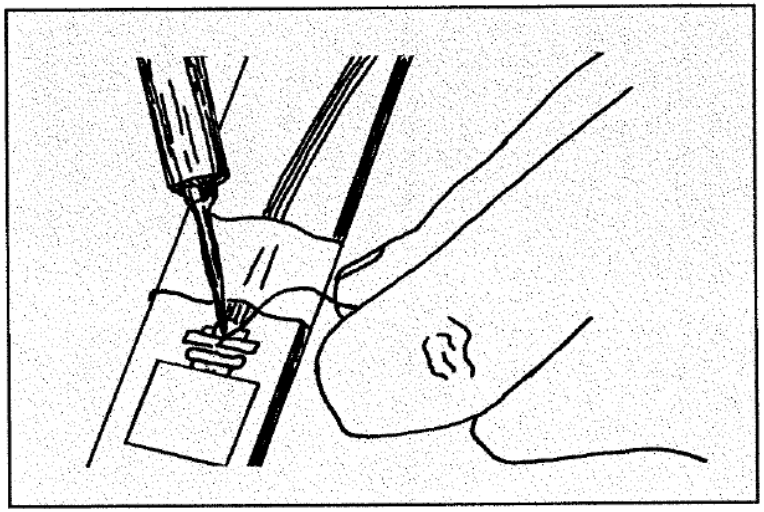
The gage and terminals should now be bonded to the specimen. To remove the tape, pull it back directly over itself, *peeling* it slowly and steadily off the surface.



Installation of strain gages: soldering & stress relief



If the strain gage is without encapsulation or preattached lead ribbons, mask the gage grid area with drafting tape, leaving only the tabs exposed.



Tape or otherwise secure the lead-in wires to the specimen to prevent the wires from being accidentally pulled from the tabs. A stress relief "loop" should be placed between the tape and the solder connections.

Recall bridge circuit

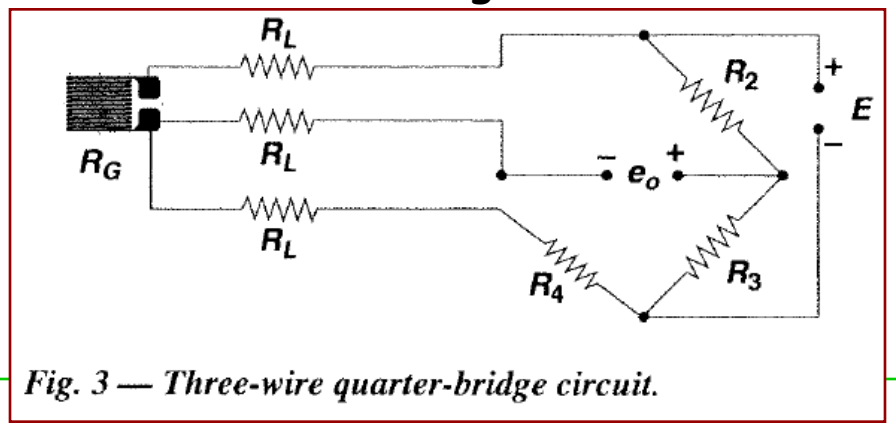
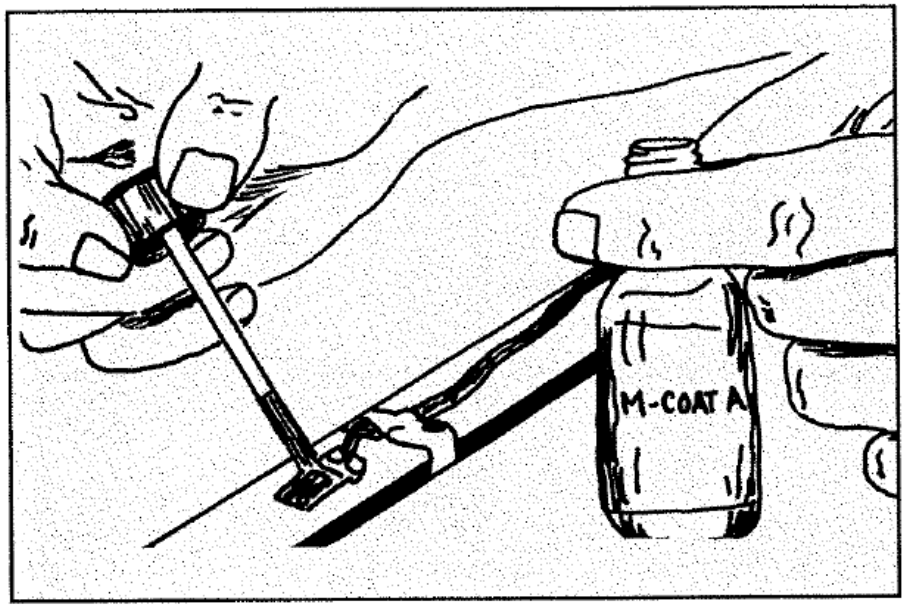


Fig. 3 — Three-wire quarter-bridge circuit.

Installation of strain gages: protecting the gage (coating)

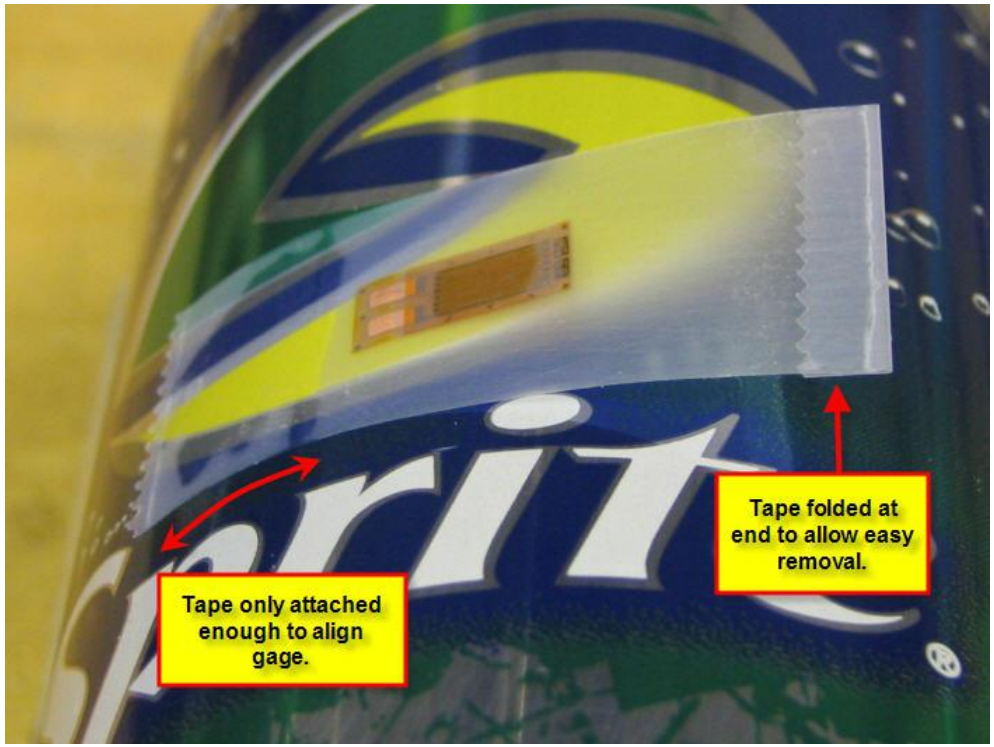
(Not used in this lab)

Apply a protective coating over the entire gage and terminal area. For most laboratory uses, M-Coat A will provide adequate long-term protection. The coating should be continuous up to and over at least the first 1/8 in *(3 mm)* of leadwire insulation.

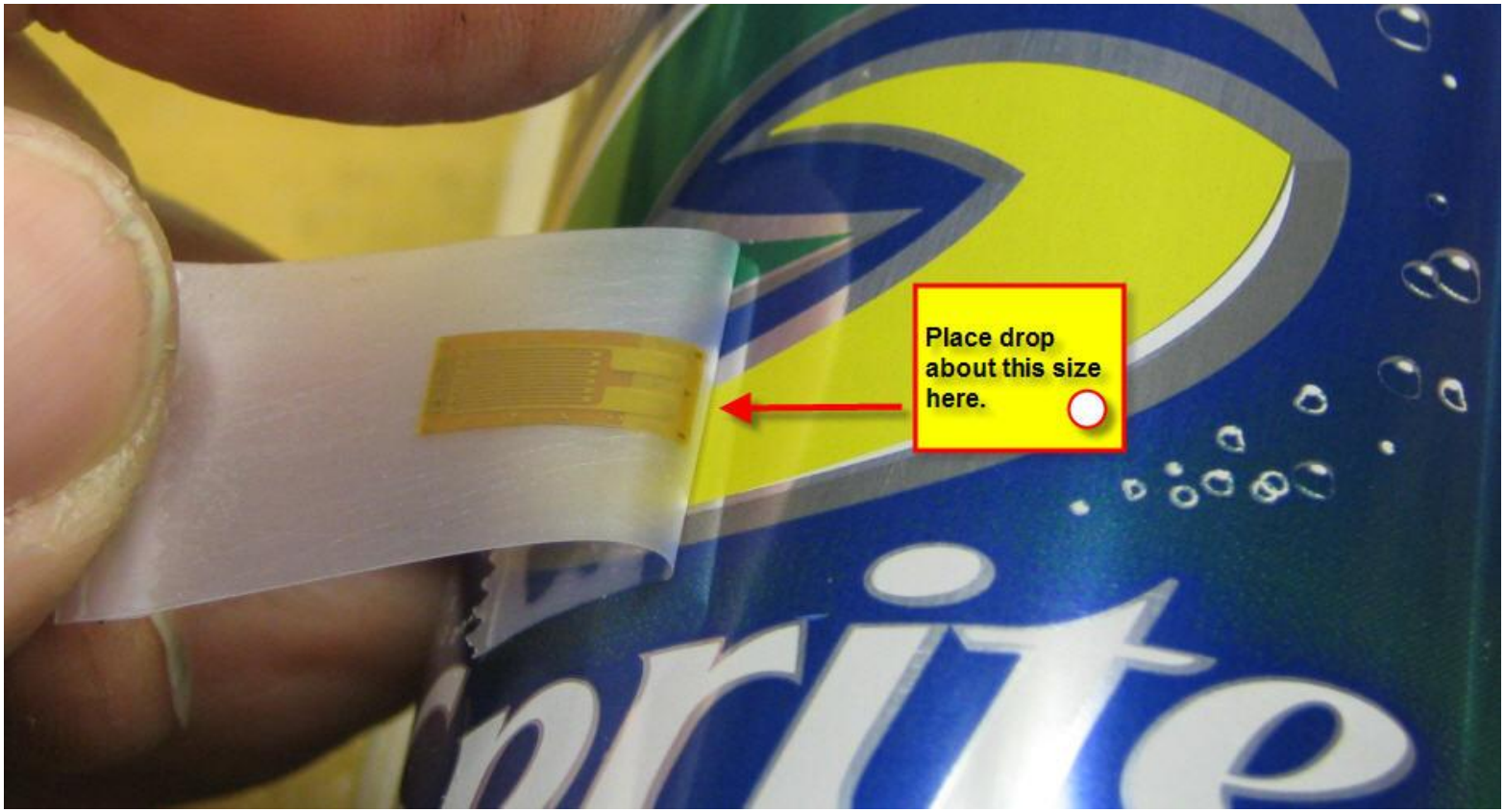


Installation of strain gages: cleaning with degreaser and aligning the strain gage tangentially

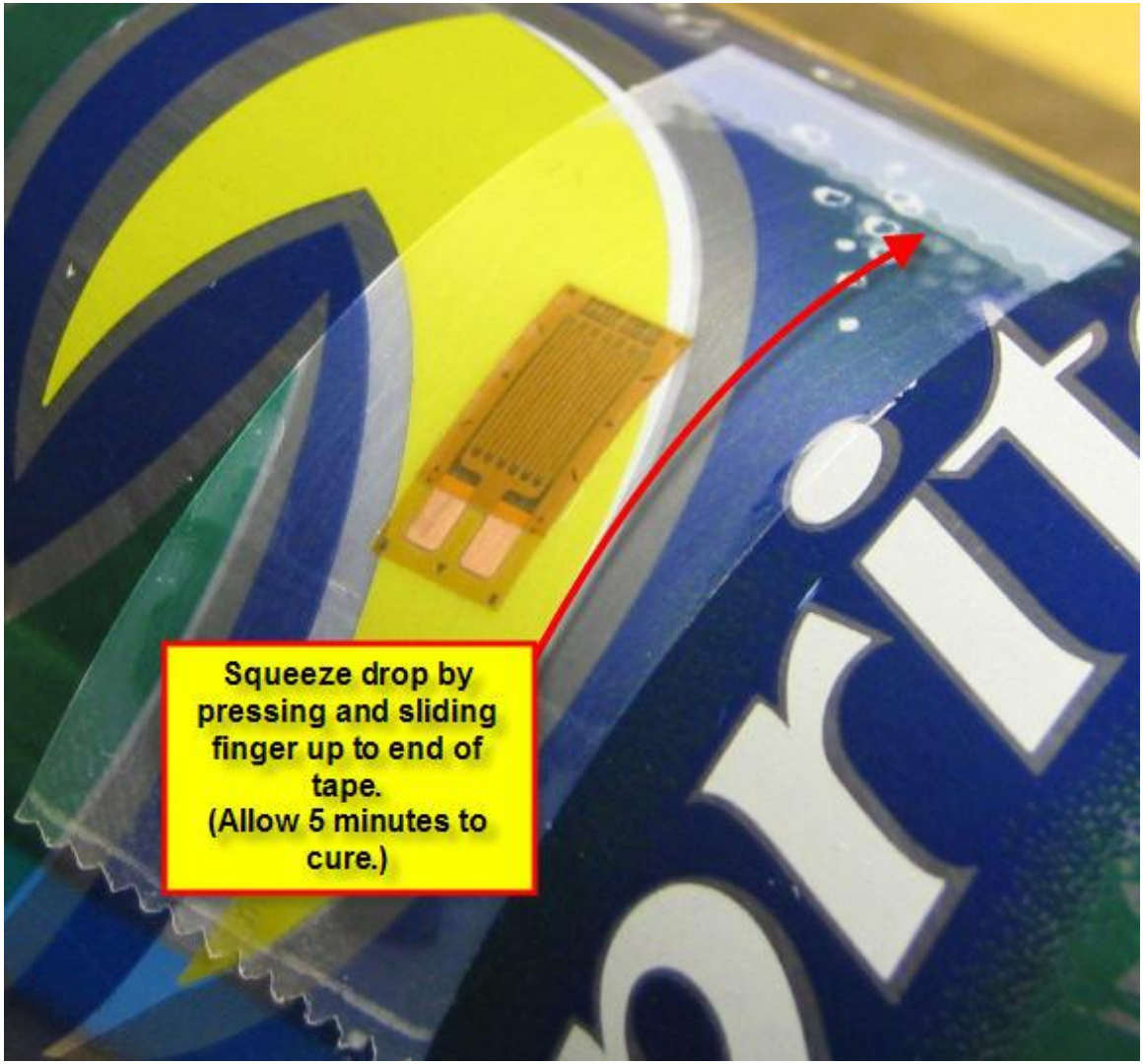
Make Sure the "shiny side" of the Stain gage looks up



Installation of strain gages: gluing the strain gage

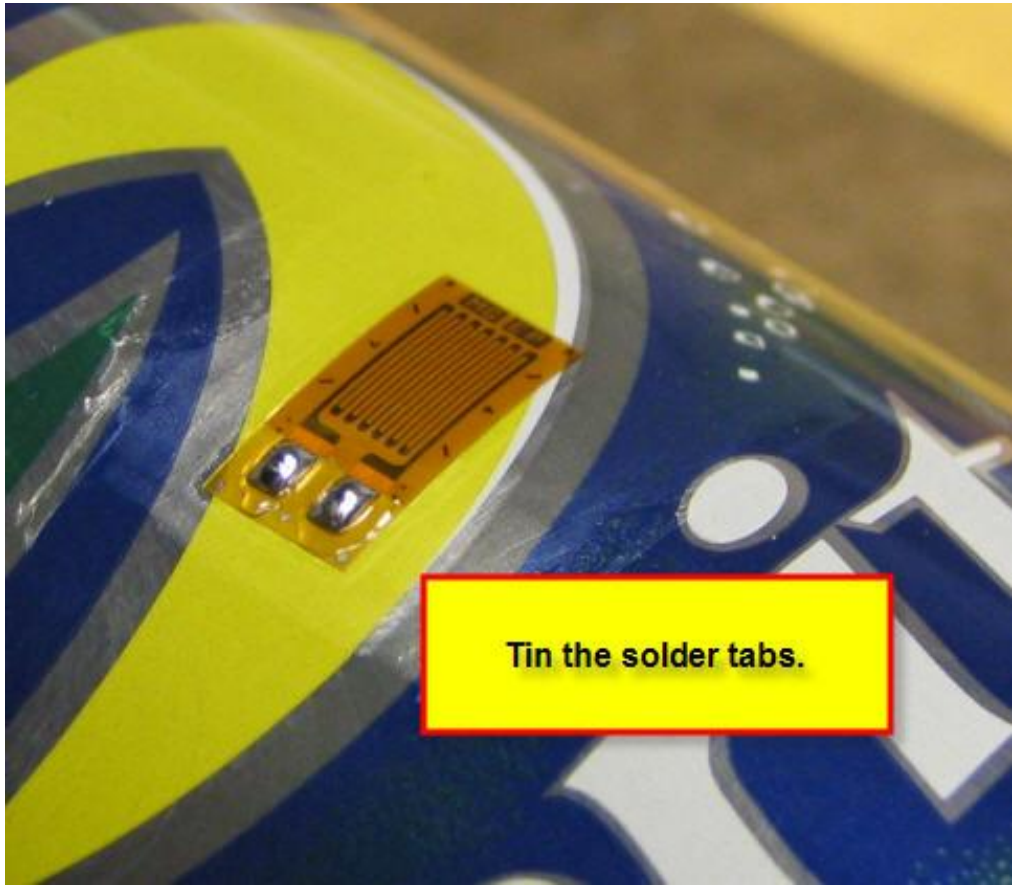


Installation of strain gages: pasting the strain gage

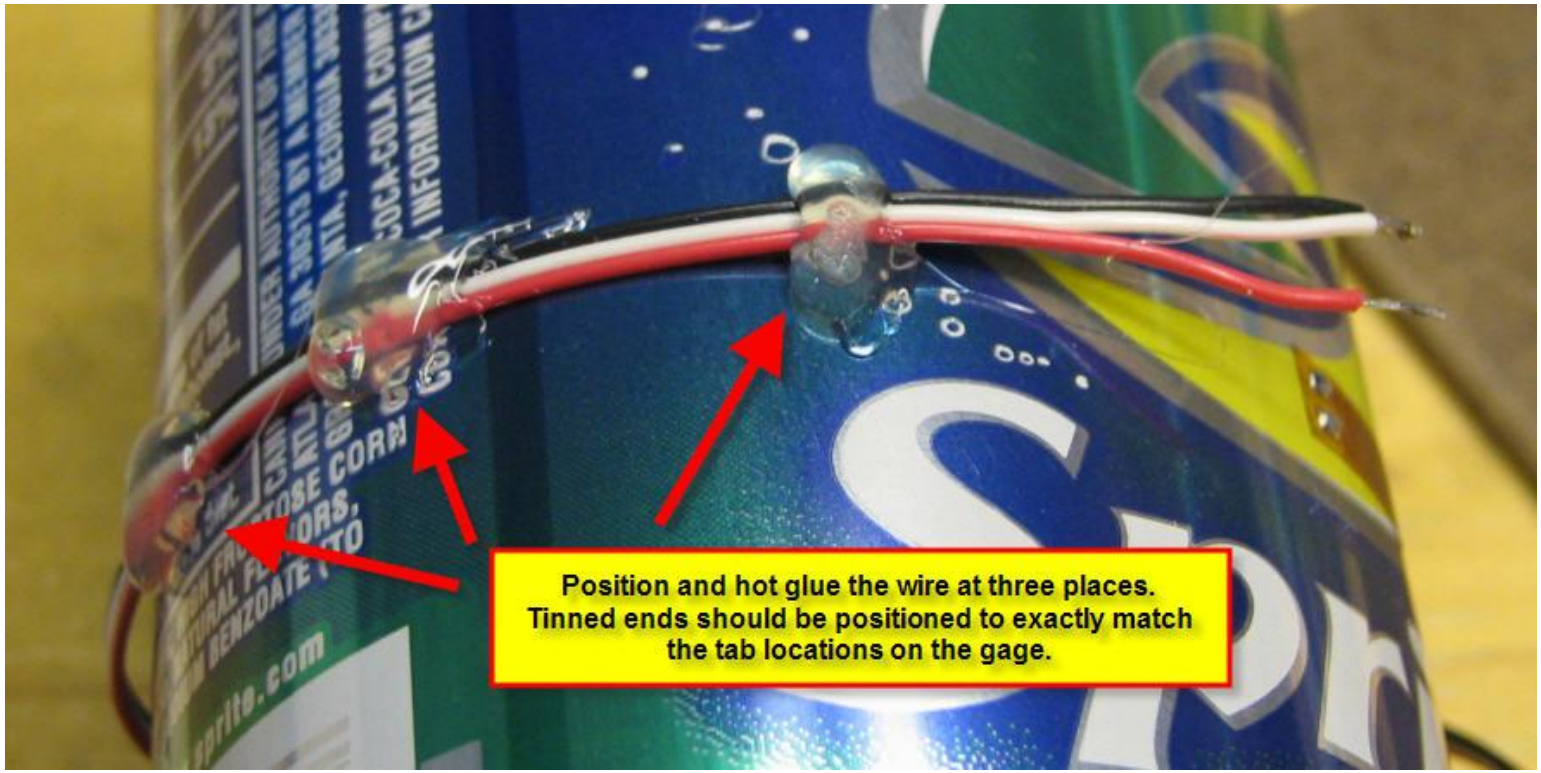


Installation of strain gages: after curing for 5-10 mins, removing tape from strain gage

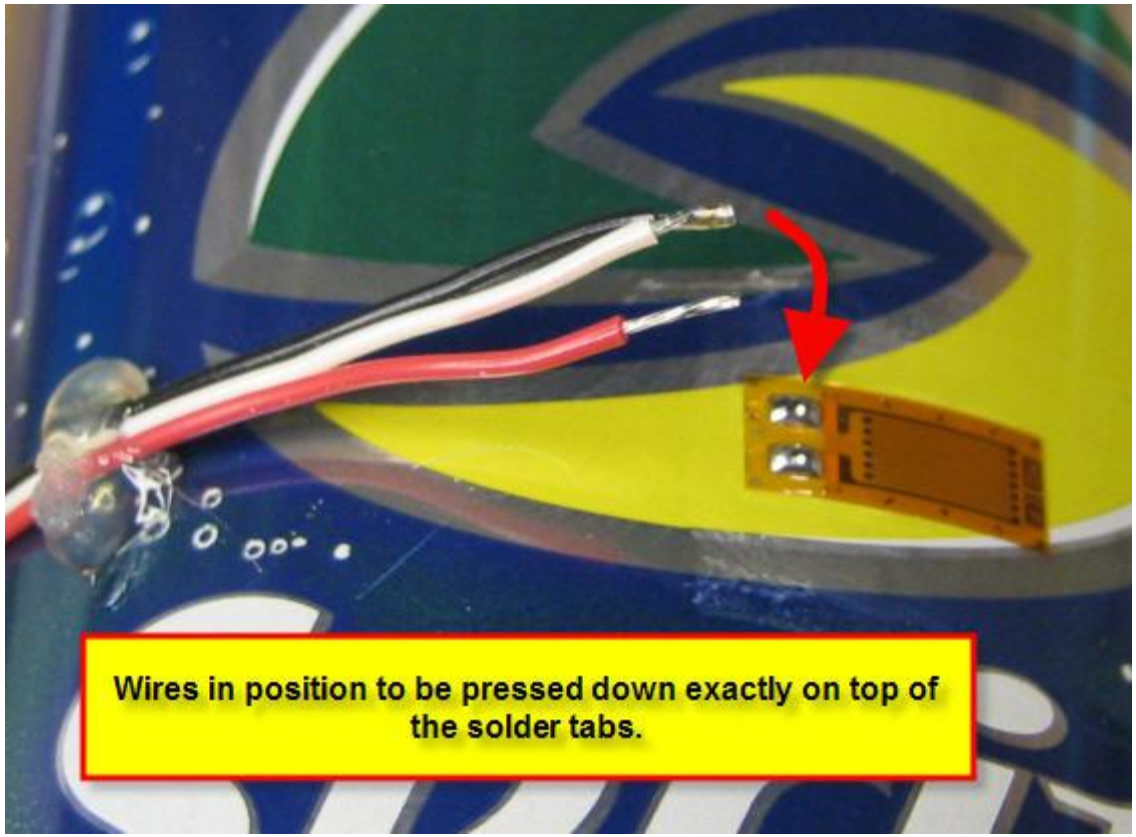
Installation of strain gages: tinning the solder tabs



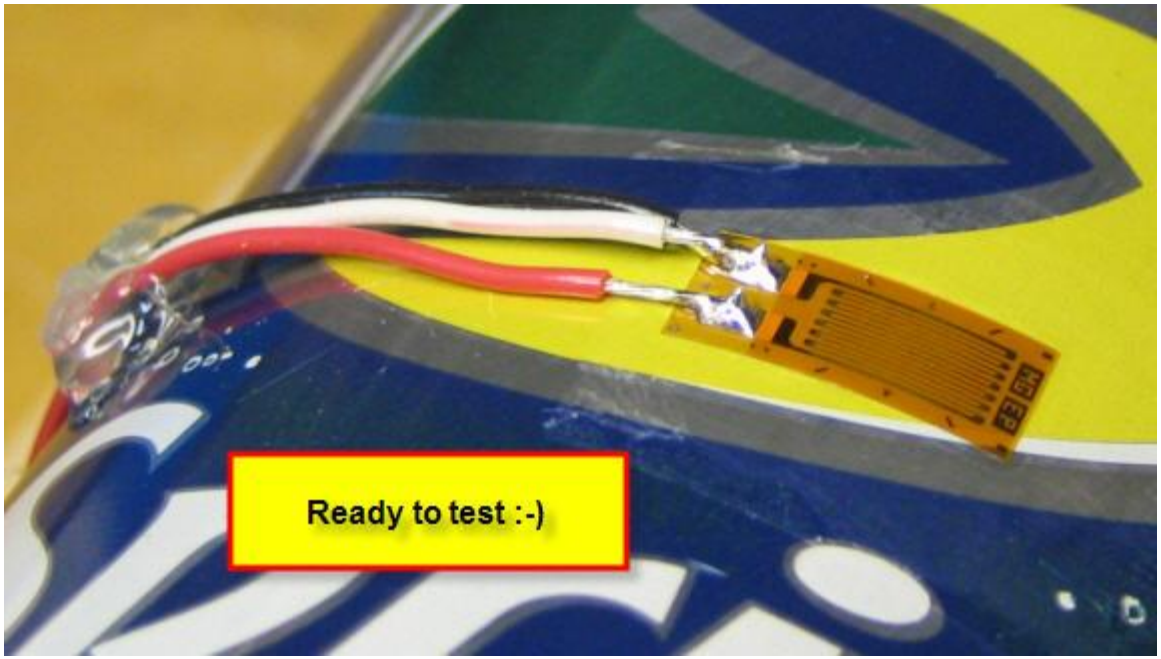
Installation of strain gages: hot gluing the positioned wires at 3 locations



Installation of strain gages: pressing the wires in position on top of the solder tabs

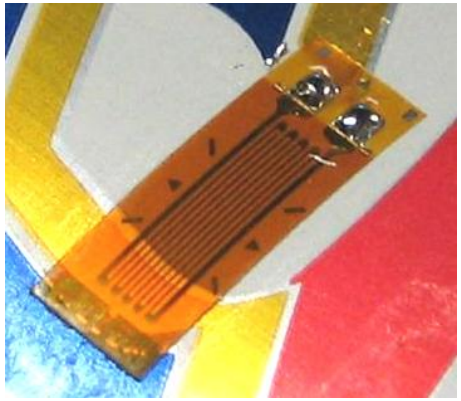


Installation of strain gages: soldering the wires to the strain gage tabs



Installation of strain gages: soldering & stress relief

Tinned terminals



Secure wires

Solder

Verify overall installation of strain gages

- A "good" experiment should always be repeated at least three times – to ensure repeatability: prepare (instrument) 3 cans
- Make sure to verify installation by connecting instrumented cans to 2310 amplifiers – make sure that three-wire $\frac{1}{4}$-Wheatstone bridges can be balanced
- Familiarize yourself with all pertinent capabilities of 2310 amplifiers