Soldering Chemistry

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Soldering is fundamentally different from gluing things together — it is metallurgy and some chemistry.

1. Metallurgy of solder

PACE: Basic Soldering Lessons playlist

- Why make soldered connections? 3:40 ---

2. Hands-on activity

2.1. Glue-style with no flux

Solder doesn't like to "stick" to bare copper, especially when the surface is (microscopically) oxidised.

Supplies

- ☐ Soldering iron
- ☐ brass sponge
- ☐ copper-clad strip
- ☐ **60** / **40** solder wire

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1. Ensure your iron is on and up to temperature.
2. Clean the tip by wiping on the brass sponge.
3. Feed some **60** / **40** solder onto the iron tip so that there is a drop on the tip held on by surface tension.
4. Wait a few seconds for the flux that is in the core of the solder wire to burn off.
5. Place the drop onto a patch of the copper-clad strip as if you are putting a drop of glue.
6. Remove the iron and place in its stand.

What you should notice

- the solder drop doesn't "want" to "stick" (much) to the copper surface
- surface tension to the tip makes it difficult to get the solder to stay on the copper surface
- solder tends to **bead up** on the surface into a ball

2.2. Flux on the copper first

Adding flux to the copper surface first helps the surface **wet**.

Supplies

- ▢ (same as previous § 2.1)
- ▢ Flux in a paint-valve-pen

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1. Shake the flux pen to ensure the solvent and flux solds are well-mixed.
2. Un-cap the flux pen and notice how it works: Pressing on the felt tip opens the valve and lets fluid soak into the felt tip.
3. Point the flux pen downwards and put the tip on a clear part of the copper surface.
4. Activate the valve by pressing down.
5. Notice the flow of alcohol solvent carrying flux solids onto the surface. Stop before totally hosing down the area and making a mess :)

Repeat the same steps as § 2.1. Then use the iron tip to smear the solder around on the copper surface.

What you should notice

- a *fizz* as the heat from the molten solder vaporizes the alcohol
- less tendency to bead up into a ball and not “stick” to the copper
- the edge of the solder on the copper is **thin and flat**

2.3. Melt-and-cool

What does it look like as solder transitions from liquid to solid?

Supplies

- ▢ (same)
- ▢ ensure you're using **Sn60** / **Pb40** solder

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1. Clean the tip of the iron on the brass sponge.
2. Add a little solder to the tip of your iron.
3. Touch this to an area with solder on it already. You are adding a little extra so we can see the *solder freezing* easier. Also spread the solder around to make a larger spot.
4. Remove the iron and watch the solder change!
5. Add the tip to melt the solder and do this several times. Add more solder if it seems useful.

What you should notice

- a "wave" / edge that travels from the edge of the solder pool inwards
- a small change in color or **sheen**

2.4. Heat → flux → solder → cool

Different solder alloys melt differently!

Supplies

- ▢ **60** / **40** solder (already using)
- ▢ **63** / **37** eutectic solder wire
- ▢ Lead-free solder wire

2.4.1. 60/40 behavior

1. Add some 60/40 solder to your iron tip and wipe off the tip on the brass sponge.
2. Find a clean part of your copper strip.
3. Place the iron tip onto the copper strip, laying down so the side of the tip is making contact.
4. Push in some **60/40** solder into the **wedge between the tip and copper**.
5. Move the iron tip around to make a larger **wetted area**. Add a little more solder if useful.
6. Remove the iron and watch the solder solidify.
7. Touch the tip back onto the pool *while “stirring” the pool as it melts (this is quick).

What you should notice

- stirring as the solder melts has a “goopy” phase just before it turns liquid
- the copper **wets** much better using this technique of heat then solder wire. This is because the **flux** in the wire’s core melts first and chemically cleans the surface!Adding more solder to make things *work* better is really **adding fresh flux**, the extra solder only affects the heat transfer.

2.4.2. eutectic 63/37 behavior

- ▢ Repeat the last actions, but this time use the **63**/ **37** *eutectic* solder.

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What you should notice

- there is no “goopy plastic” phase when stirring before this solder melts
- the freezing happens **really quickly**.
- how long it takes to freeze after removing the iron depends on how hot you heated up the pool to

2.4.3. lead-free behavior

- ▢ Clean the iron tip again and well.
- ▢ Repeat the last actions.

Be careful to not mix the solders together --- it changes the alloy!

What you should notice

- it takes more “heat” go get this to melt --- its melting point is quite a bit higher
- the cooled solder has a matte finish instead of being shiny

2.5. Wire-to-board connections

Supplies

- ▢ 3 solder wire alloys
- ▢ flux pen
- ▢ 4-5 segments of stranded hookup wire with 8mm stripped ends

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1. Twist the stripped wire end so it doesn't tend to fray.
2. Add some liquid flux to the bare wire end so the flux wicks into the strands.
3. Somehow hold the wire so you can have both hands free for the solder wire and iron.
4. Clean your iron tip on the brass sponge. (notice that we always do this before using it!)

Select a solder alloy and remember which one you have.

1. Place the iron tip **under** the wire
   a. Touch the solder wire to the top of the wire to have a stack:
   iron — wire — solder
   b. use only a **tiny** amount. You only want to wick solder into the spaces in the strands.
2. Put the iron back and wait for a few seconds for the wire end to cool.
3. Bend a ~30 degree "foot" on the freshly **tinned** wire end.
4. Clean your iron tip and find a patch on your copper strip that has the **same solder** on it.
5. Place the wire flat onto the solder patch.
6. Place the iron tip flat onto the wire and lightly press down. This should melt the solder in the wire and on the patch. (If not, add a tiny amount of solder to the tip to **aid with heat transfer**)
7. Remove the iron and hold the wire still until the solder freezes.

What you should notice

- solder quickly and easily **wicks** into the wire strands if everything is clean
- the solder on the patch forms a **concave fillet** between the wire and copper
- holding the wire still can be tricky

Do the previous activity with a fresh wire, but use different solder alloys.

Notice the **cooling / solidifying** action especially! The 60/40 and 63/37 are different in the moments just before and after freezing.