

Electronic Soldering Workshop

No actual soldering needed



Presented by: Mark Landress WB5ANN

Soldering Workshop Outline

Introduction & Safety

What is it and Things to Solder

Things to Solder

Equipment & Accessories

Soldering Procedures

Circuit Boards, Flux and Solder Types

Soldering Irons & Tips

Surface Mounts

Examples of the Good and the Bad

De-soldering

More of the Good and the Bad

Solder Chemistry & Alloys

The Real Source of Solder



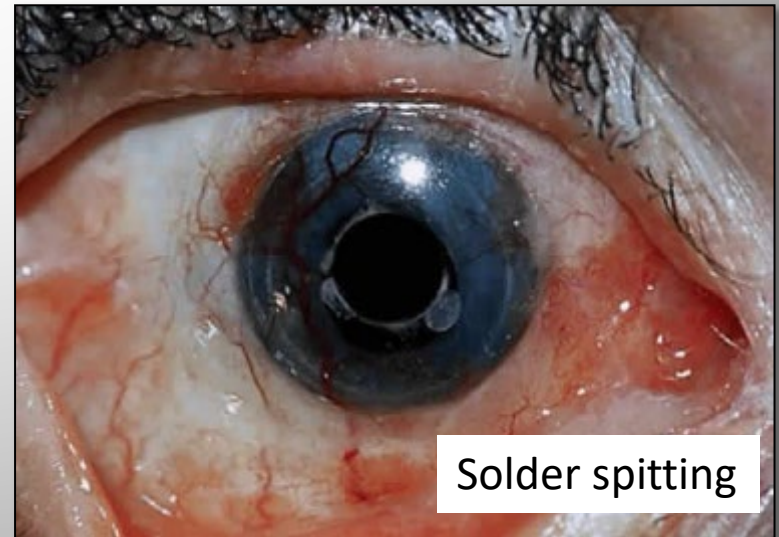
Introduction

- Solder is a fusible metallic alloy used to join metal parts together. Different types of solder alloys are available depending on the type of connection desired.
- Solder joints provide a conductive connection for electrical circuits.
- They must also perform mechanical shock, vibration, and temperature induced tensile stress.
- The act of applying solder – *is soldering*.





Safety First - Be Careful



Lead is Poisonous

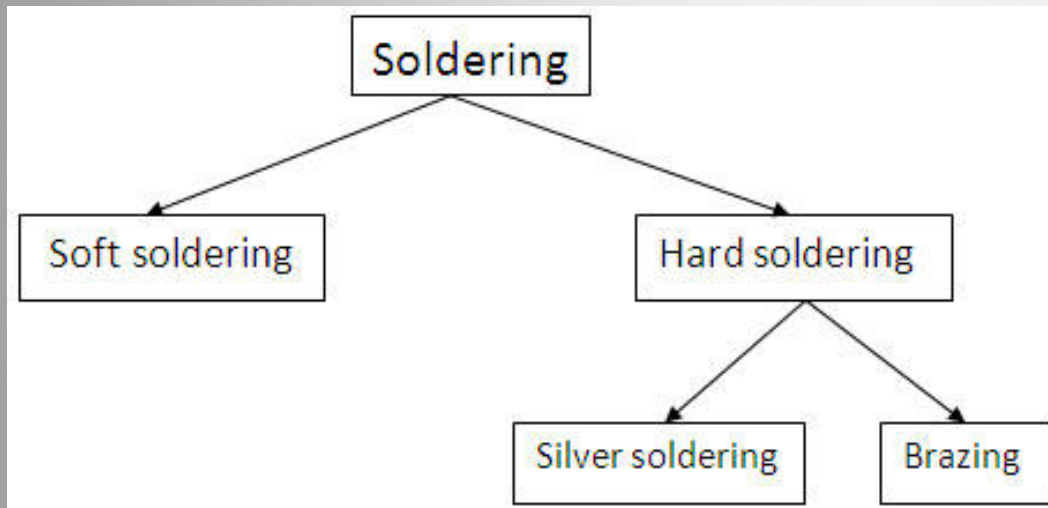


Work in a clean well ventilated area.



- Lead can cause behavioral problems and learning disabilities.
- Lead residues can reach several hundred PPM on skin.
- GI, uro & neuro involvement from overexposure.
- Don't breath the smoke.
- Don't put solder in you mouth.
- Wash hands after use.
- Note that some components, silvered & tinned or zinc connectors, paints and coating also can have high levels of lead.

Soldering – What is it?



- **Soft** – Joining small parts with tin-lead alloy
- **Hard** – Joining 2 metals by expanding into the work piece (plumbing)
- **Silver** – Joining thin and thick items (not good at filling gaps)
- **Brazing** – Joining base metals



Basic Soldering Equipment

- 15 Watt handle mounted heating element and metal tip for small jobs.
- Good enough for wire but may have enough thermal transfer for larger connectors.
- Operates at 190-250 deg C.
- Easy to burn through cloth, insulation, desk, plastic etc.
- The iron should be placed on a stable stand when not in use.
- More professional units incorporate a sponge or metal wool to clean the tip.



Soldering Equipment



Fixed or adjustable temperature iron



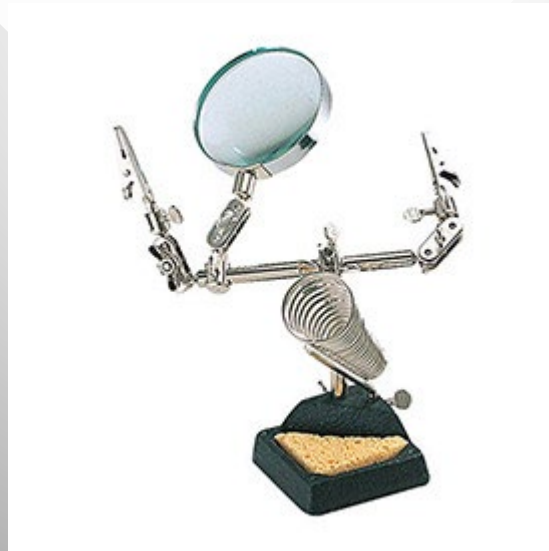
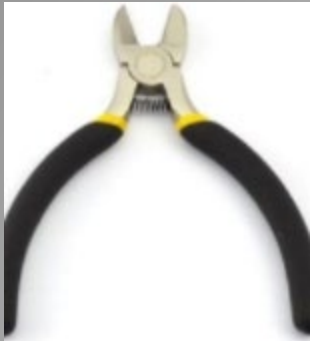
Holder with sponge

Brass wool pad



Do not use steel wool on hot irons.

Accessories



Soldering Procedure



Get stuff ready



Scrape tip



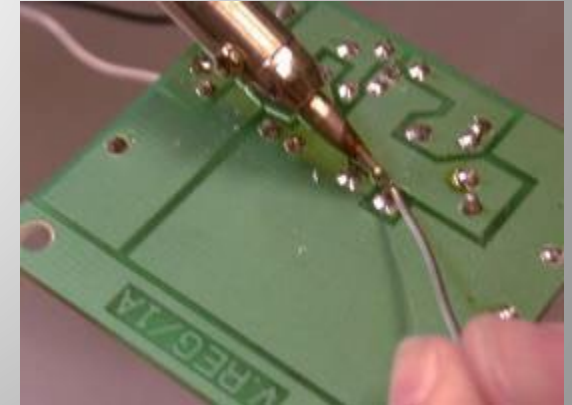
Shock tip w/ moist sponge



Add flux as needed



Tin iron tip



Start Soldering

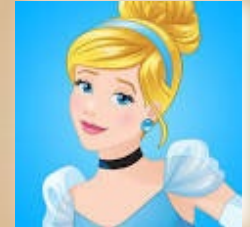
How should the tip look?



ooohhhh



ahhhhhh



Yikes!!!



What Do We Solder?



Old Style Circuit Connections

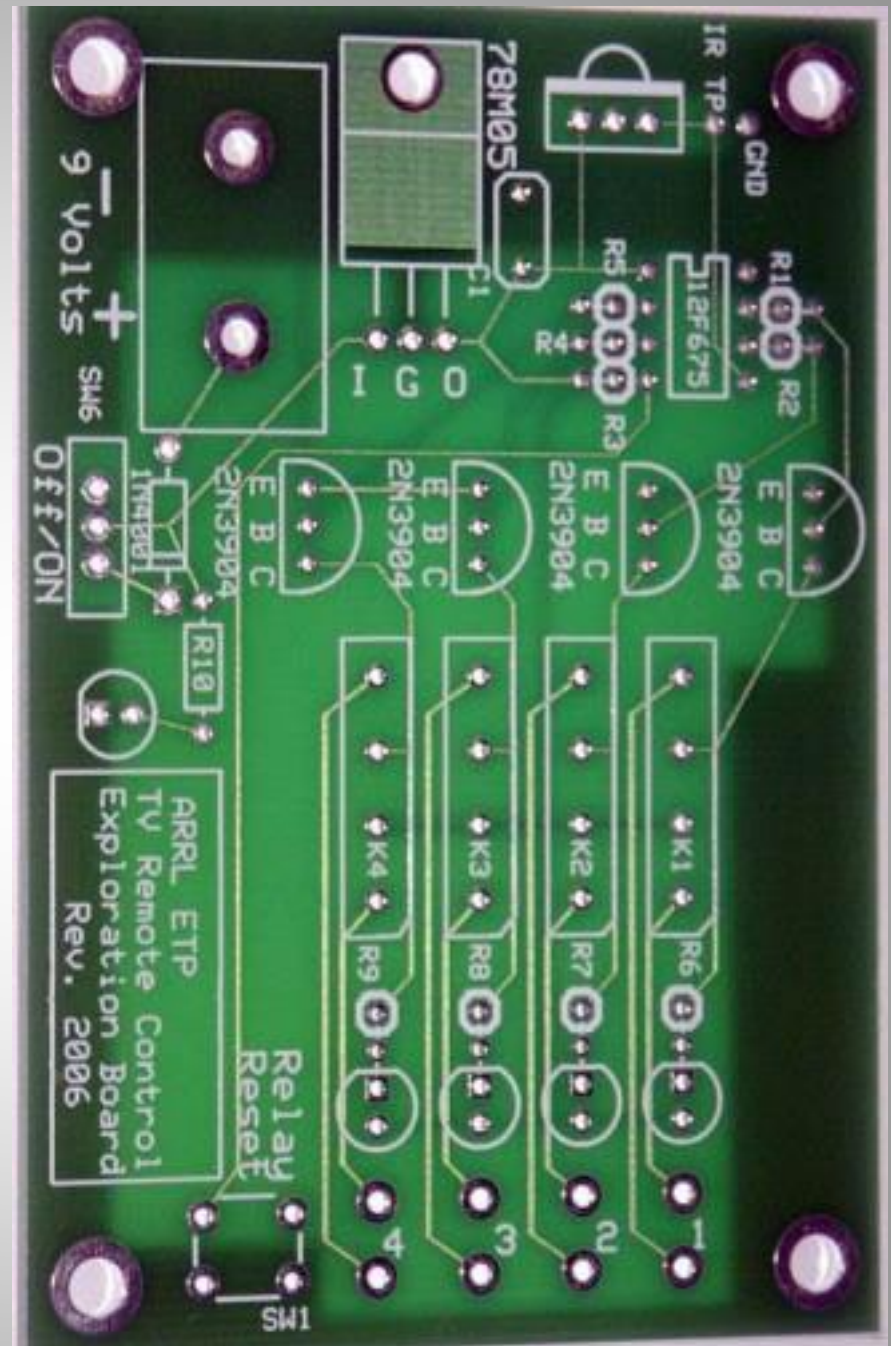
- Point-to-Point wiring
- Physical (mechanical) connections
- Lugs
- Component leads
- Junctions
- Surface Mount

The good old days.



Circuit Boards

- Component outline with label.
- Typically double sided
- Solder pads with foil trace
- May be mechanically or chemically etched.
- Now almost exclusively done by computer



Other things....



Flux – What is It?

Cleaning and flowing agent to remove oxidation and improve solder wetting

Acid Type

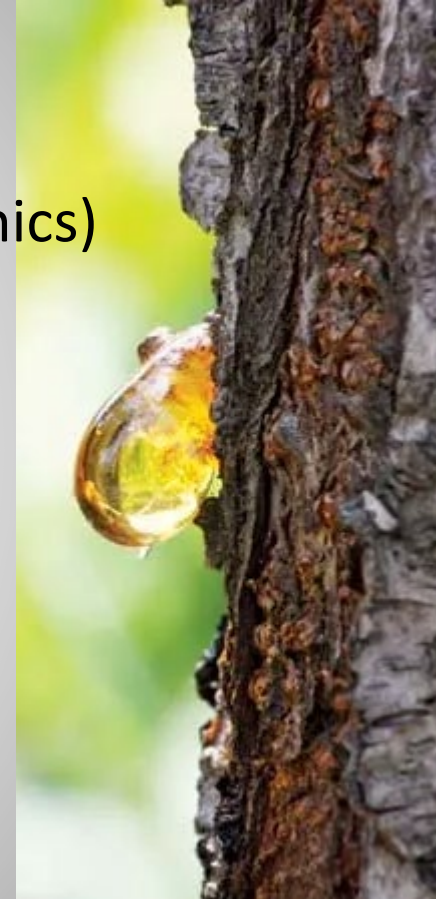
- Metalworking, plumbing (never use for electronics)

Rosin Type (for electronics)

- Rosin – tree sap dissolved in alcohol
- Removes surface oxide forming protective coat
- Unlimited shelf life

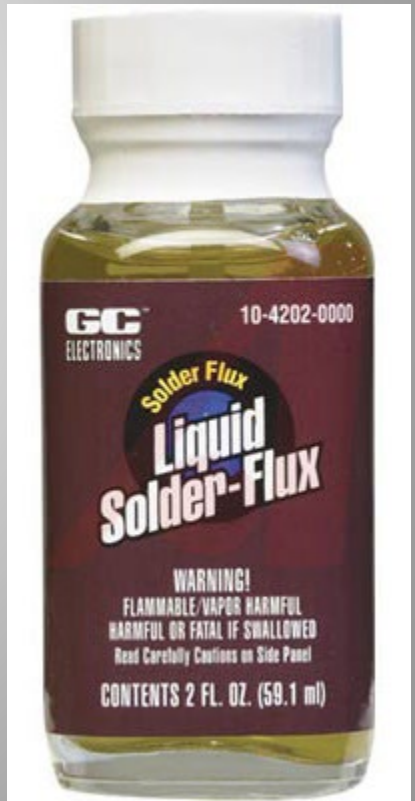
Water-Soluble

- Various organic polymers
- Easier to remove but can be corrosive
- Hygroscopic and can cause dendrite growth
- Limited shelf life





Flux – in its many forms



Solder – Lots of Types

Like everything else. It's a science.



ALLOY COMPOSITION	MELTING RANGE	TENSILE STRENGTH (ksi)	CREEP RESISTANCE
Sn63/Pb37	183°C	4.92	Moderate
CASTIN	217°C	5.73	High
Sn96.5/Ag3.5	221°C	8.90	High
Au80/Sn20	280 °C	40.00	Excellent
Sn95/Ag5	221 - 240°C	8.09	High
Sn95/Sb5	232 - 240°C	8.15	High
Sn5/Pb85/Sb10	245 - 255°C	5.57	Excellent
Sn5/Pb93.5/Ag1.5	296 - 301°C	4.30	High
Sn5/Pb92.5/Ag2.5	299 - 304°C	4.20	High

*Additional alloys available upon request

Compatible Fluxes No-Clean, Water Soluble, Rosin



Bismuth Solders



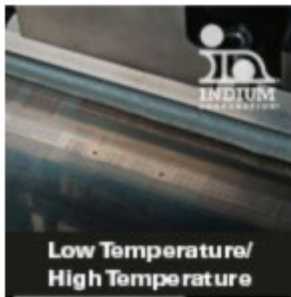
Gold Solders



Indium Solder and Sealing



Bar Solder



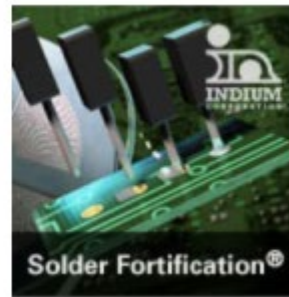
Low Temperature/
High Temperature



Preforms



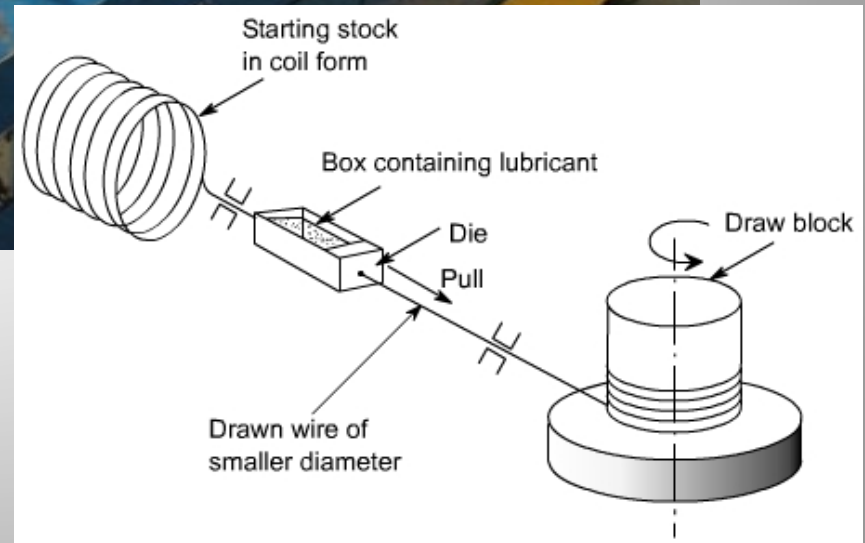
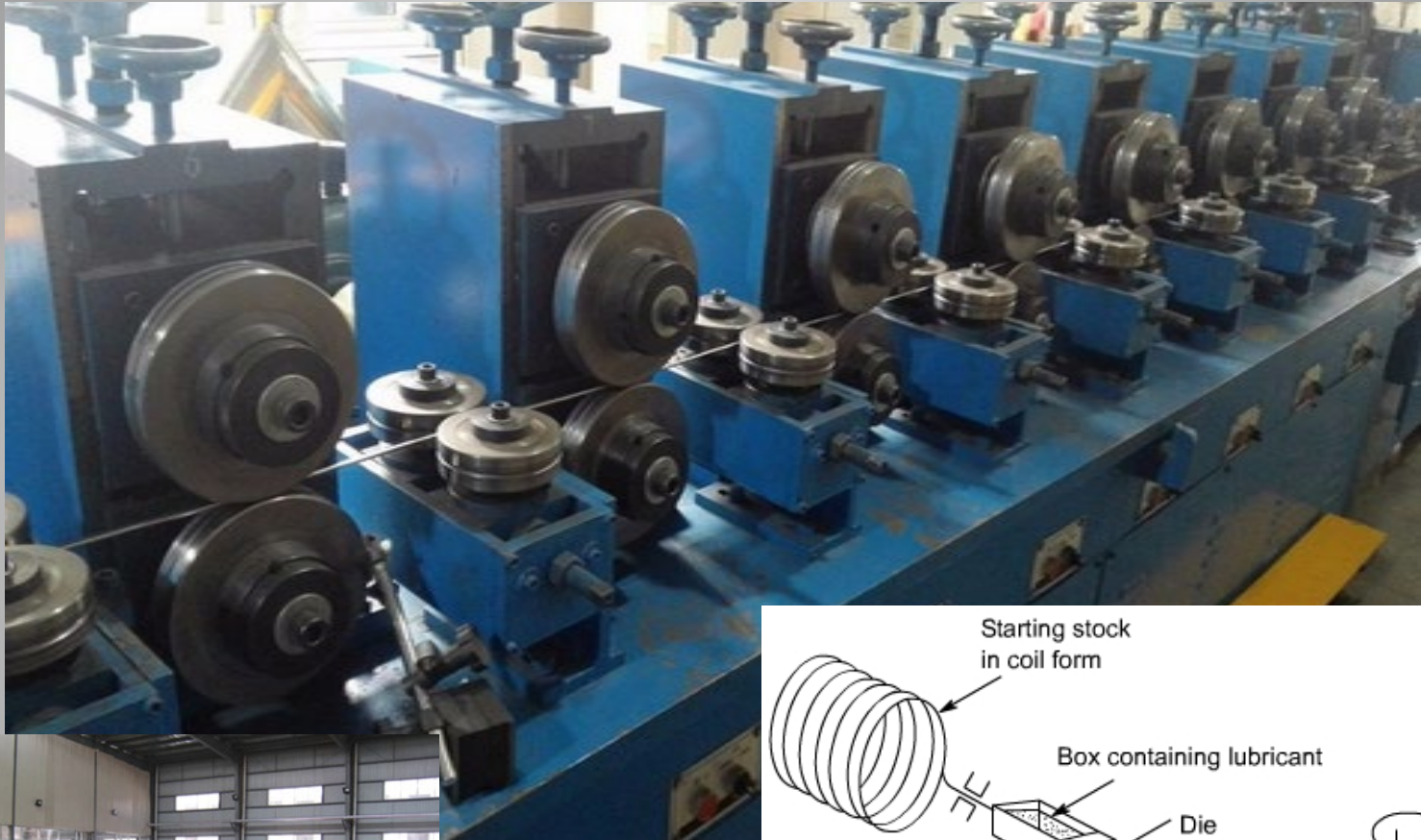
Ribbon and Foil



Solder Fortification®



How Solder is Made



Irons – Lots of Types



Basic



Soldering Station



Gas



Gun



Battery



Hot air rework



De-soldering



Olden Days

Heavy Duty Irons



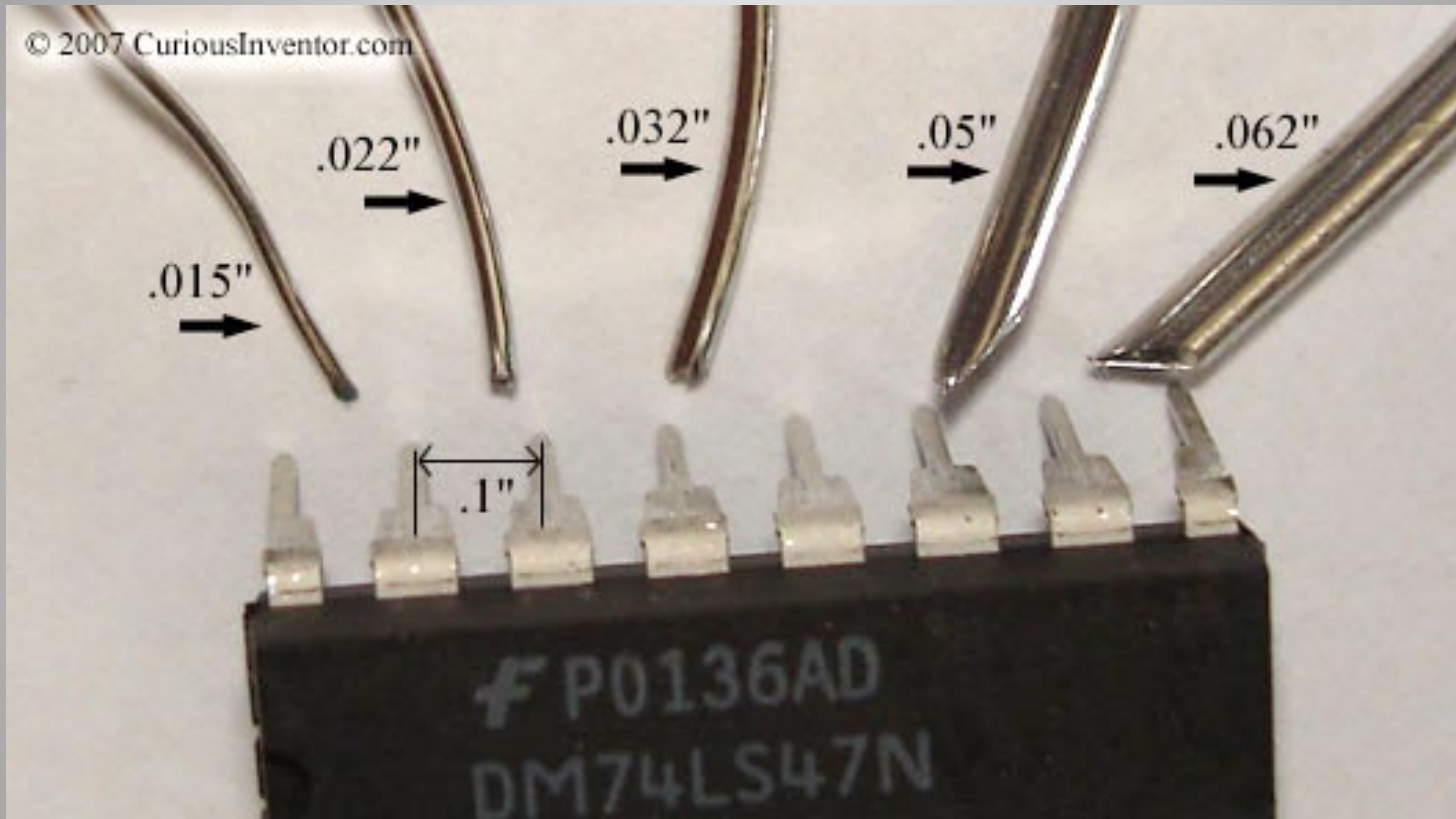
Wattages over 100. Available for heavy wires, conduit, connectors and other uses.

Soldering Tips



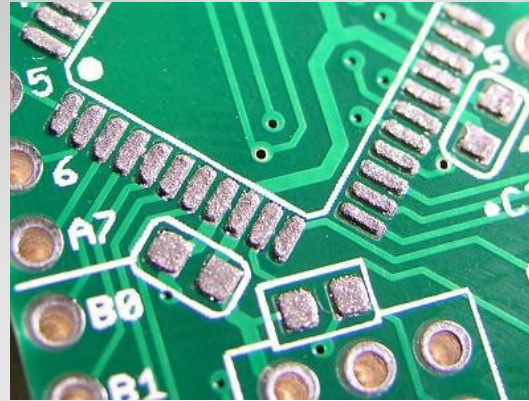
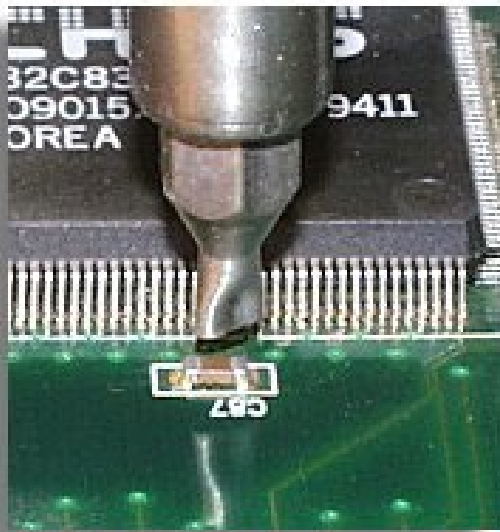
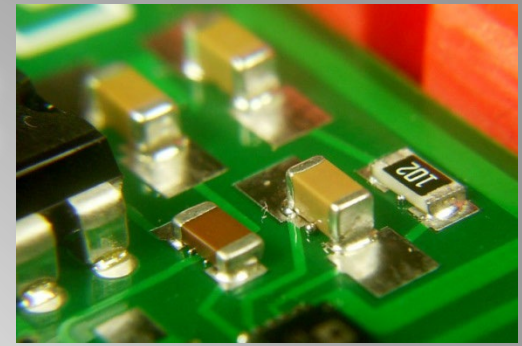
Solid metal copper and bronze tend to corrode. Newer designs are resistant to corrosion and long lasting.

Solder Diameter



Comes in different diameters depending on the application.

SMT Soldering



- Hot air used instead of contact
- Good for fragile components
- Some use solder paste

- Shallow pitch iron with regular solder
- Can be used with paste
- Production done with wave soldering or mask-applied solder paste

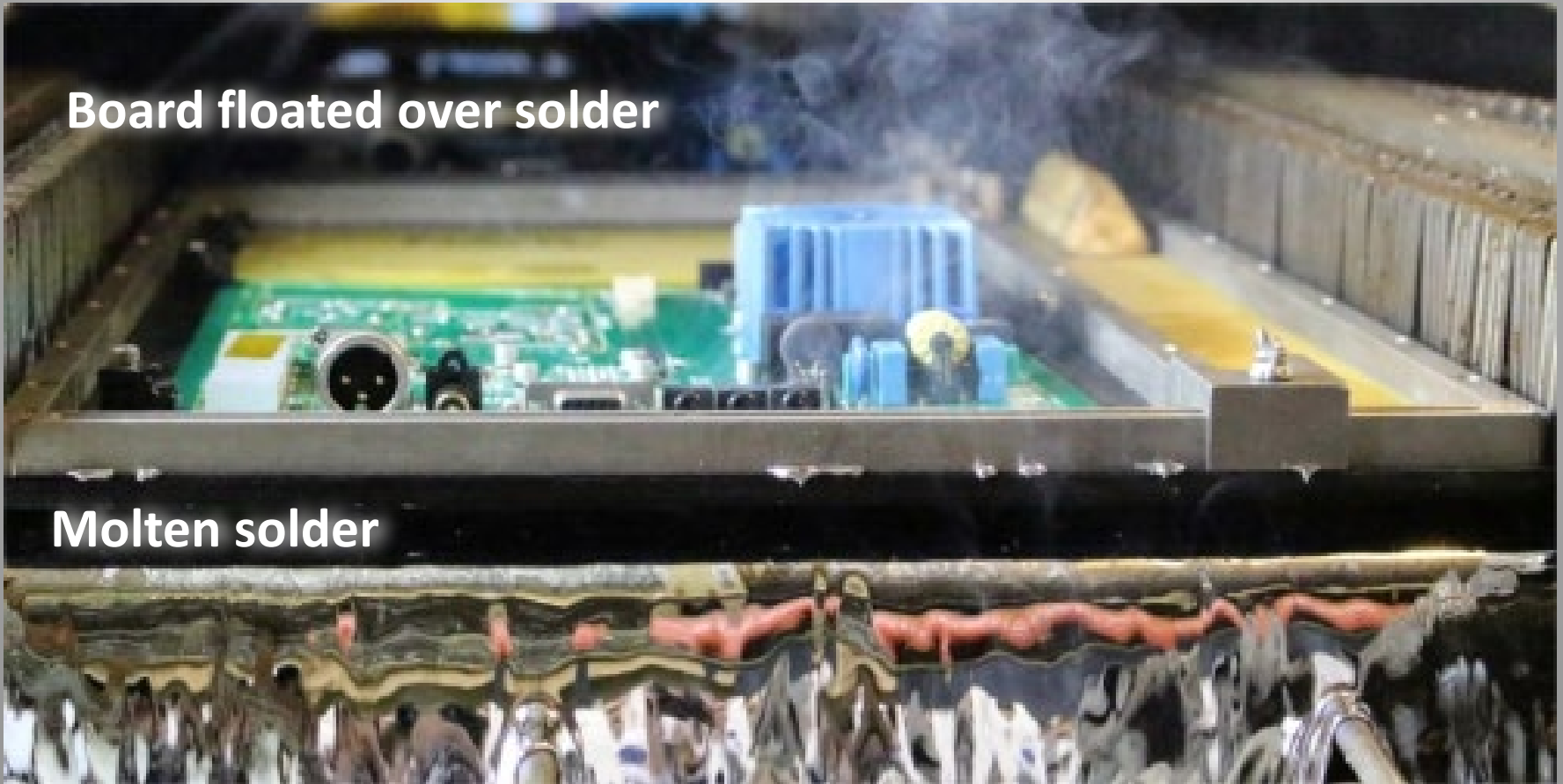
Wave Soldering

Large scale soldering process for printed circuit boards. Waves of molten solder are used to attach components to the board. Boards and components are preheated and solder wave binds multiple components at once.



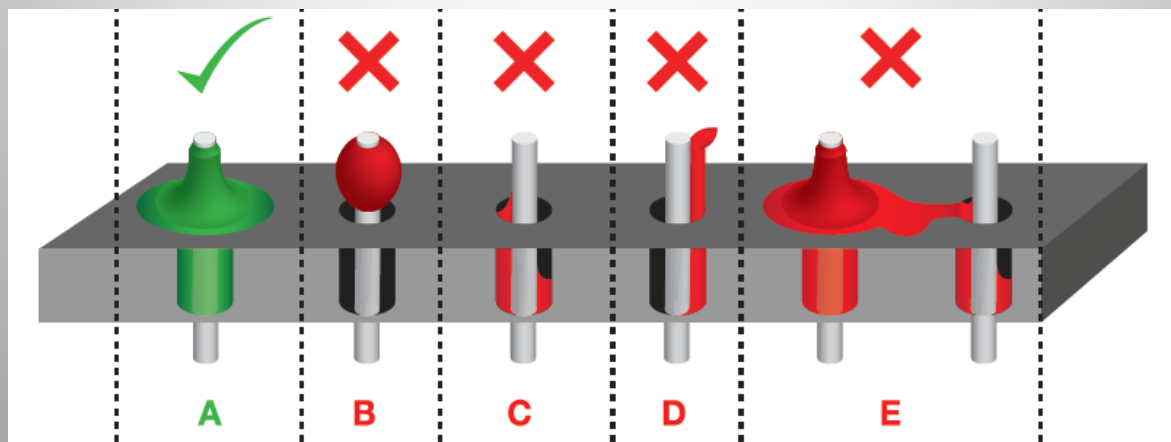
Board floated over solder

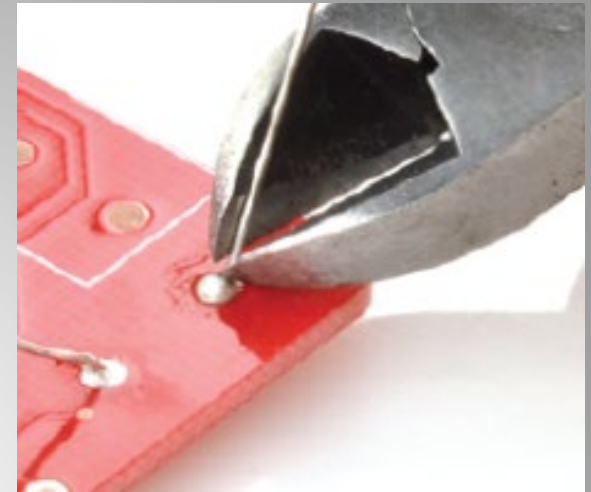
Molten solder



Making the Perfect Solder Joint

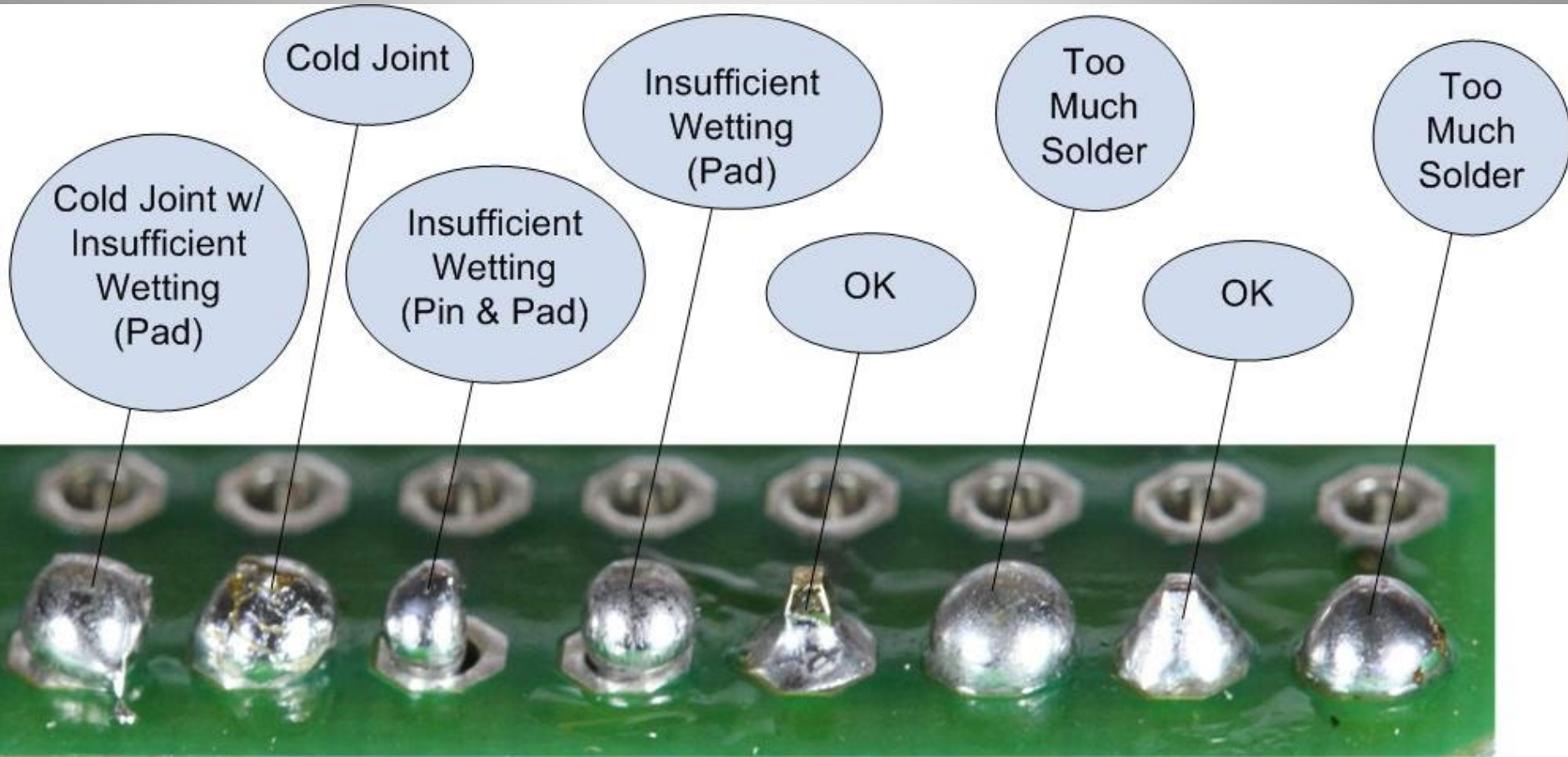
1. All parts must be clean and free from dirt and grease.
2. Secure the work firmly.
3. "Tin" the iron tip with a small amount of solder.
4. Clean the hot tip on a damp sponge.
5. Heat parts of the joint for a few seconds.
6. Continue heating, then apply solder.
7. Remove and return the iron safely to its stand.
8. Do not move parts until the solder has cooled.



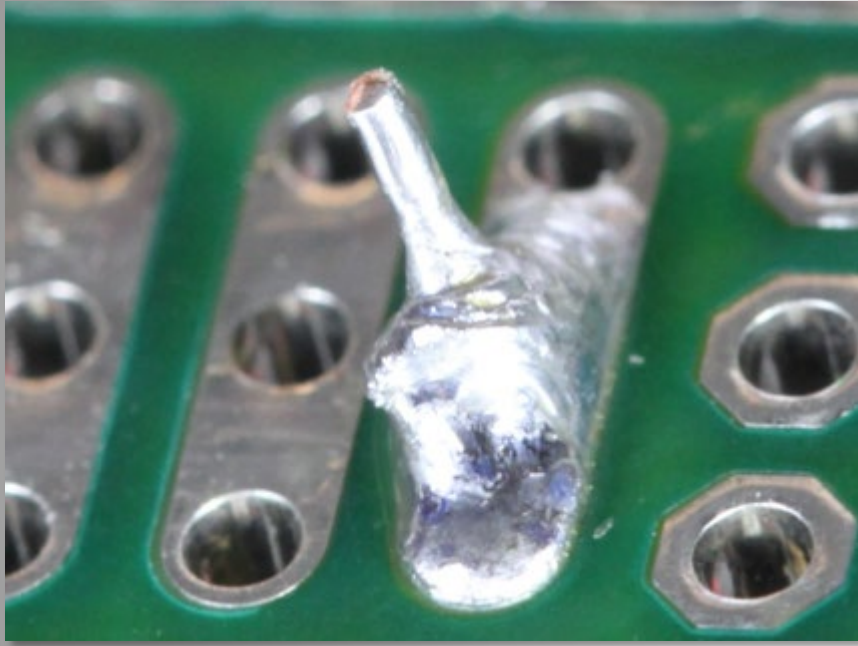


- **Insert the part into the correct holes**
- **Add flux**
- **Hold the iron touching both the pin and the tab**
- **Feed solder from the pin side enough to fill the hole, cover the tab and secure the component**
- **Remove solder, then the tip**
- **Let cool to a shiny luster**
- **Snip off excess wire**

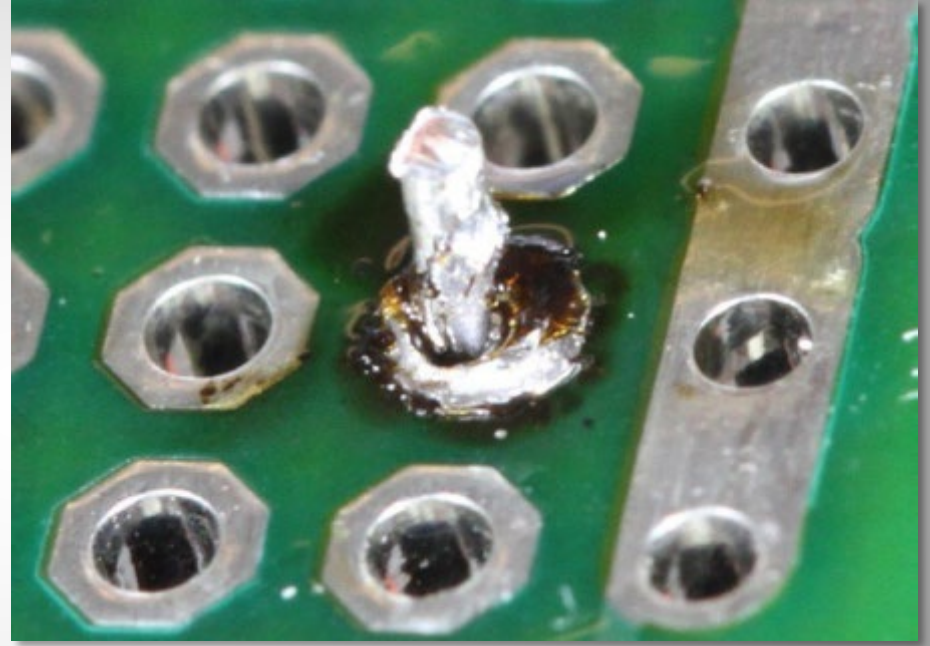
Examples



Common Defects

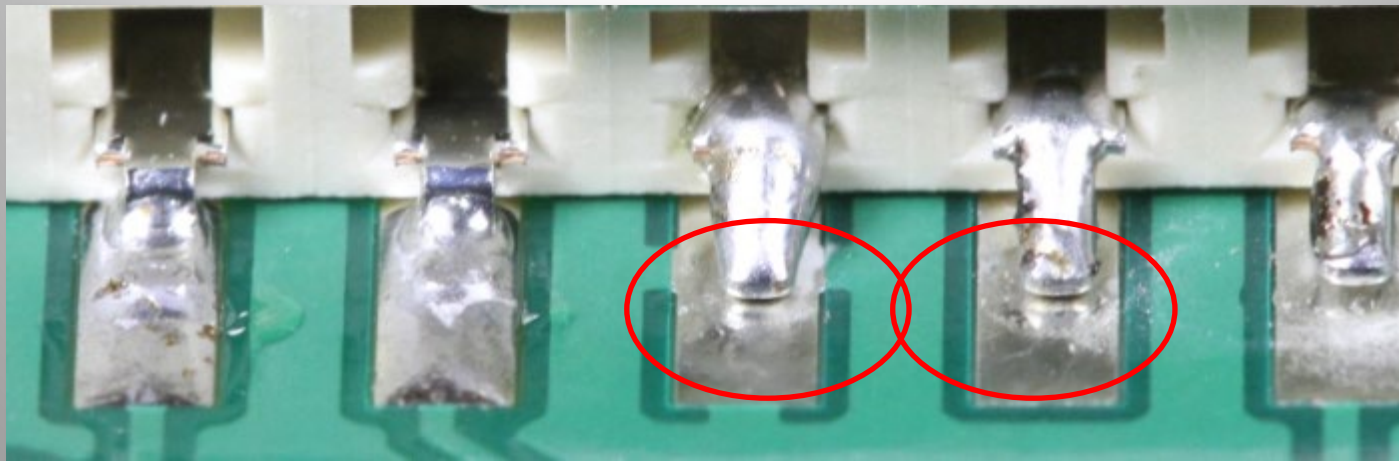
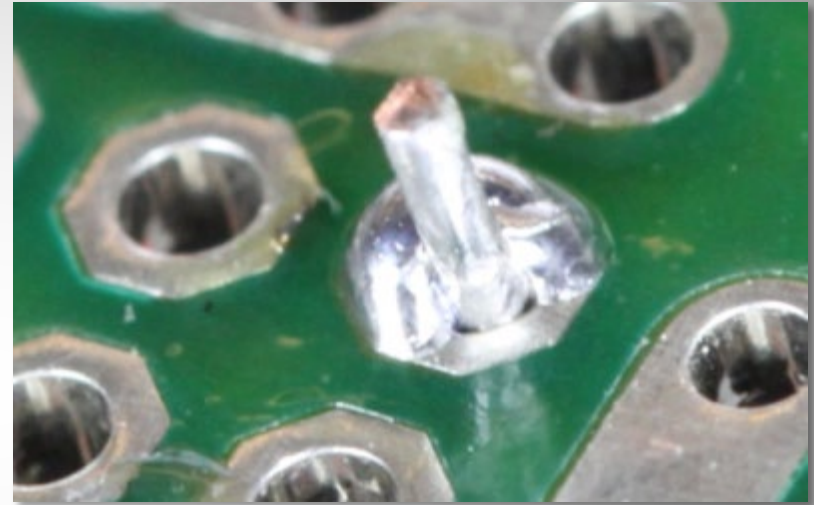
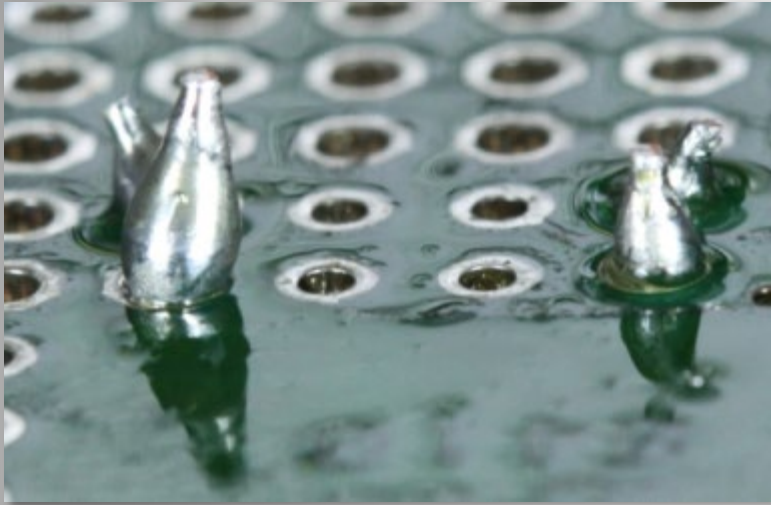


Cold Joint



Overheated

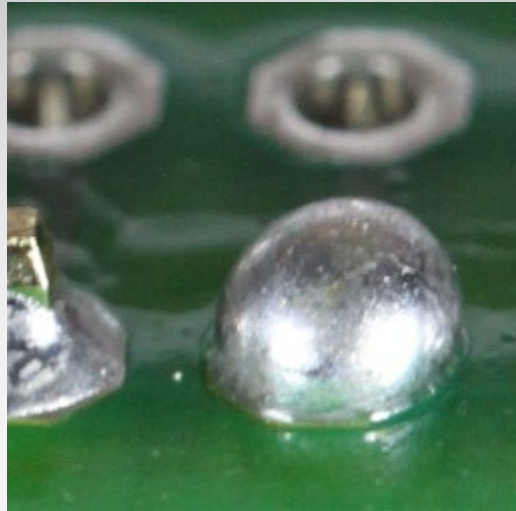
Insufficient Wetting



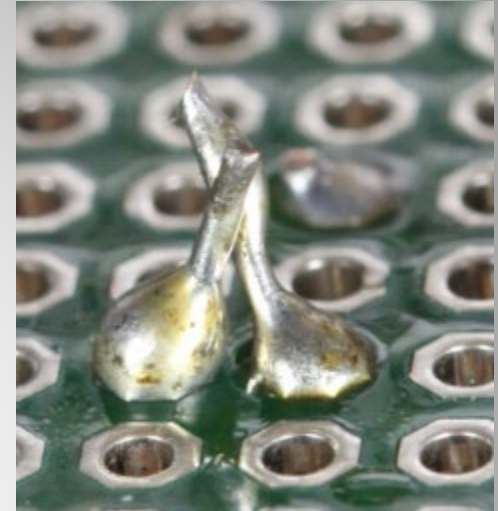
Other Defects



Insufficient solder



Too much solder



Shorted connection



Raised Tab



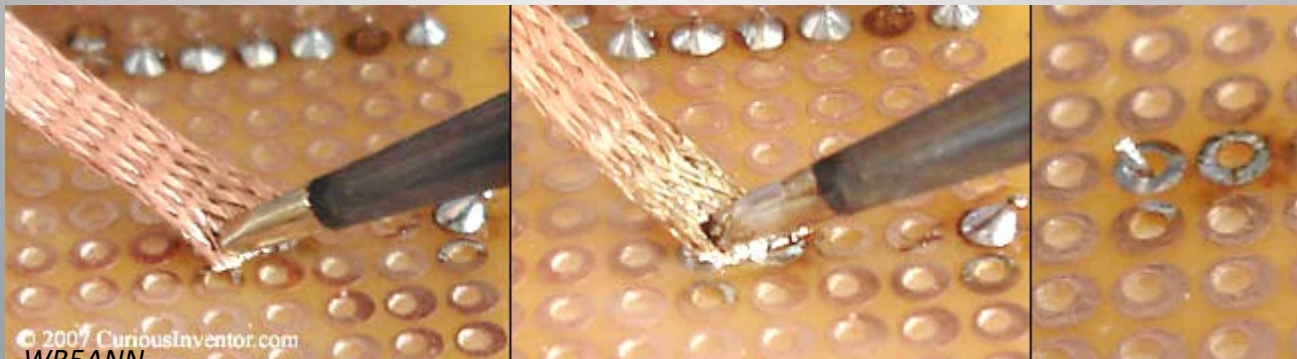
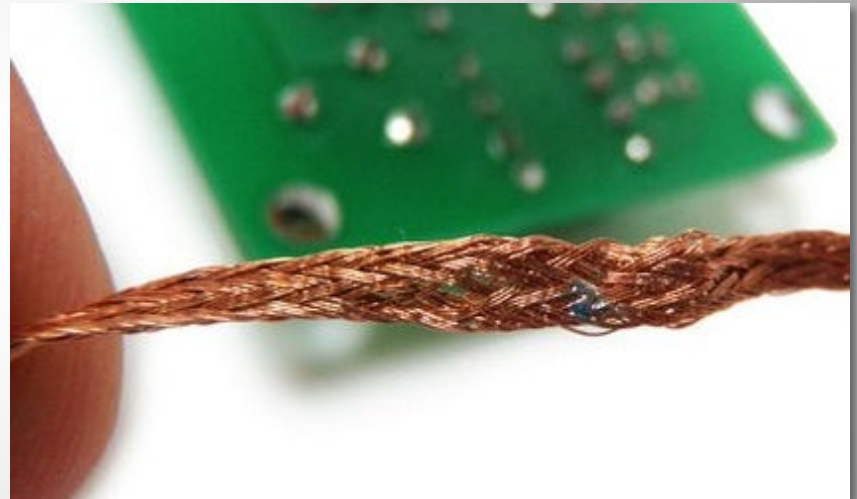
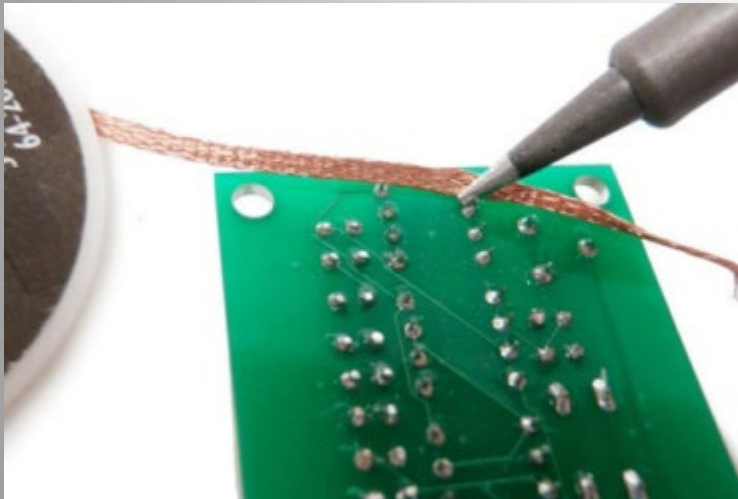
Solder Bridge



Splatter

De-soldering

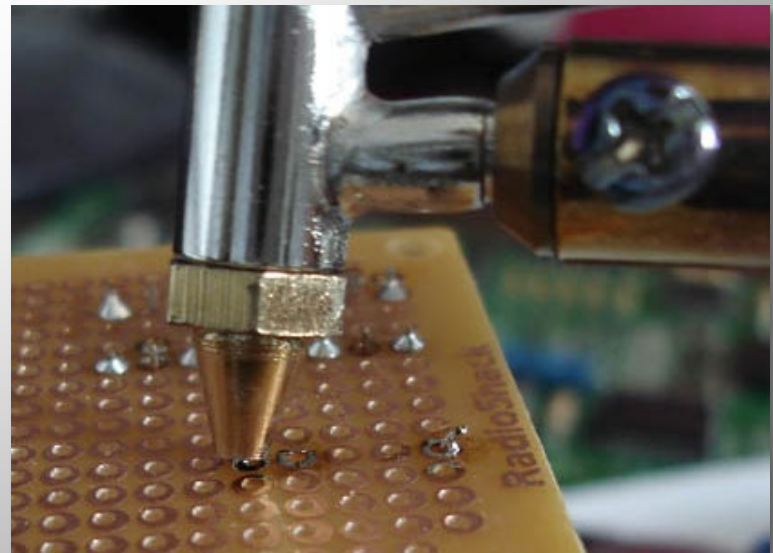
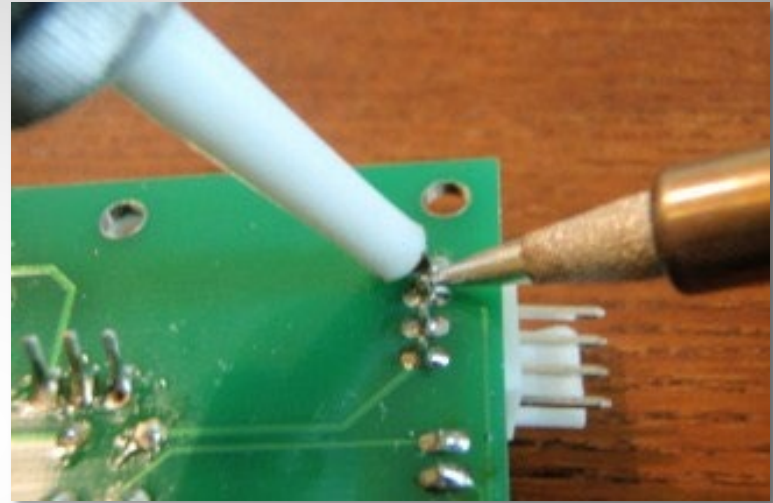
De-soldering involves removing solder from the work piece. Solder wick is effective for circuit boards. Size the braid to the work.



© 2007 CuriousInventor.com

De-soldering Pumps

Crude and sometimes effective



Professional-grade De-soldering

The only way to go for modern circuit boards



PL259 Connector

Probably the thing that most hams will eventually solder.

Strip to length

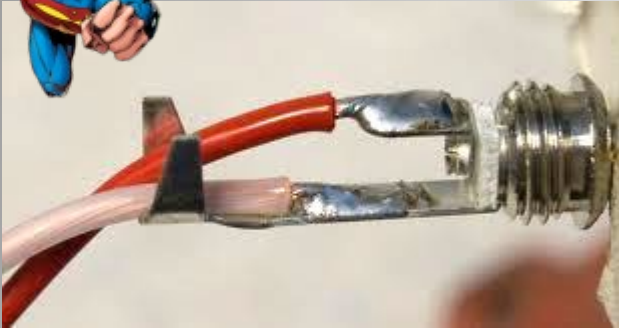
Solder the braid and cut

Screw on over insulation and solder

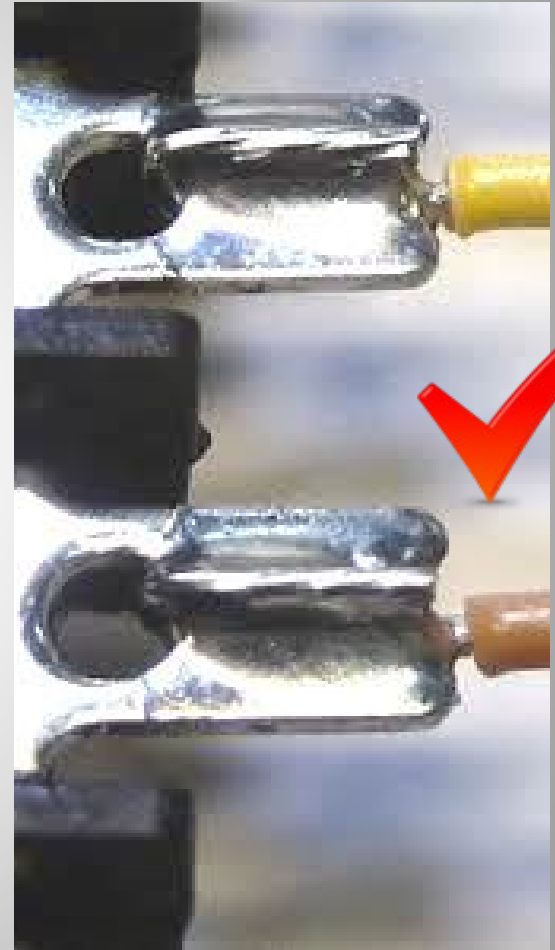
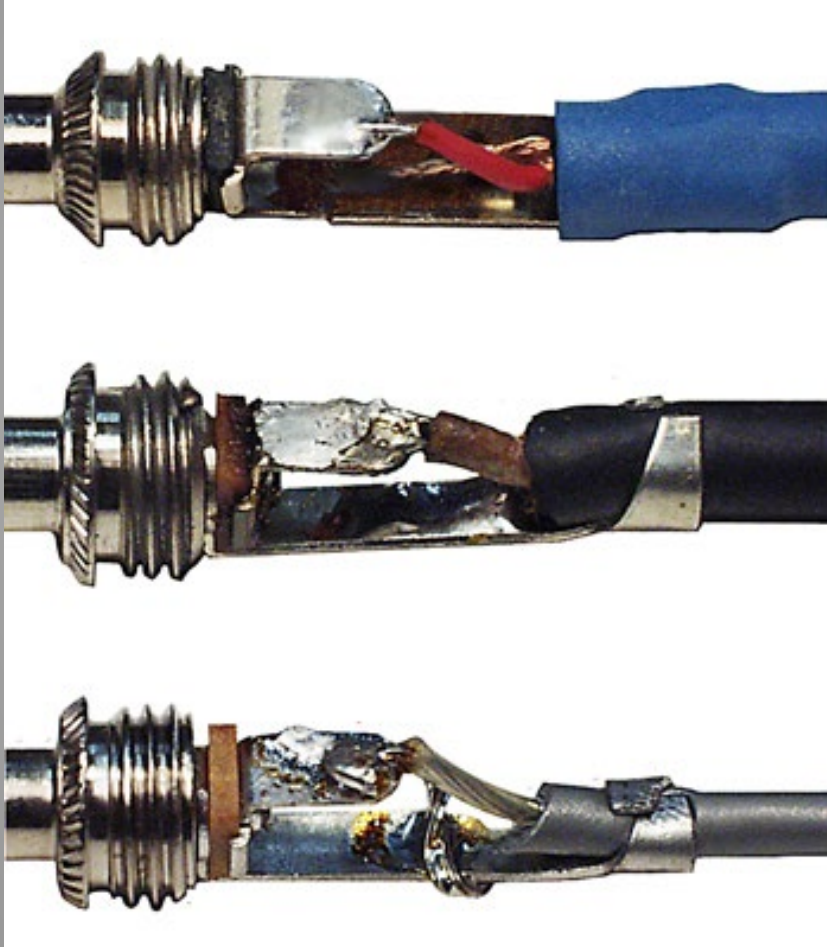


Insufficient wattage is the single greatest problem with soldering connectors.

The Good & the Bad



More of the Good & the Bad



Now That You are Good

Association Connecting Electronics Industries



IPC Hand Soldering Competitions Around the World



Upcoming Competitions

Past Competitions

Press Releases

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Who's the Best of the Best in Hand Soldering?

Do you or does someone you know have what it takes to win at hand soldering?

The reliability of electronic equipment is ensured by zero-defect soldering processes. This contest recognizes the best skills in hand soldering complex printed board assemblies.

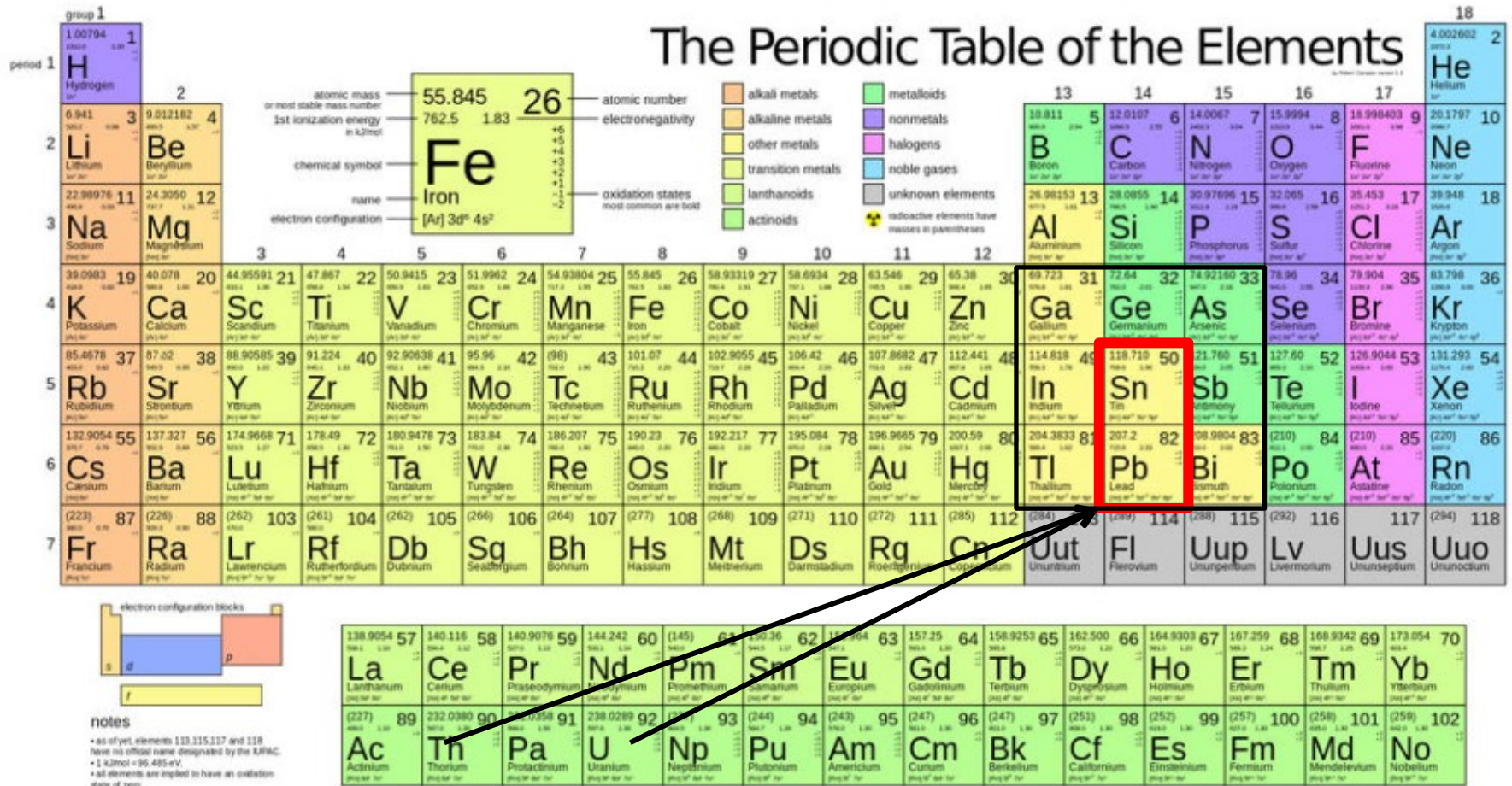
Participants will compete against each other to build a functional electronics assembly within a half-hour time limit. Assemblies will be judged on soldering in accordance with IPC-A-610E Class 3 criteria, the speed at which the assembly was produced and overall electrical functionality of the assembly. IPC-A-610 Master Instructors will serve as the judges.

View the upcoming IPC Hand Soldering Competitions:

Monthly

[IPC Hand Soldering Competitions in India - Bangalore, India](#)

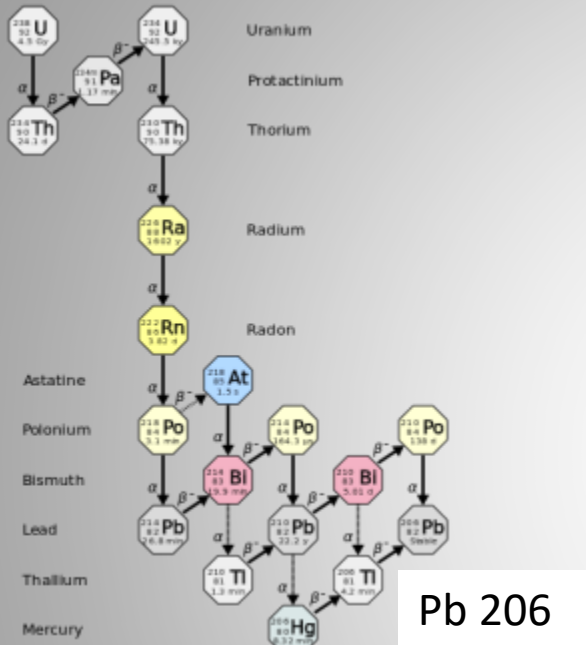
Solder – Chemistry



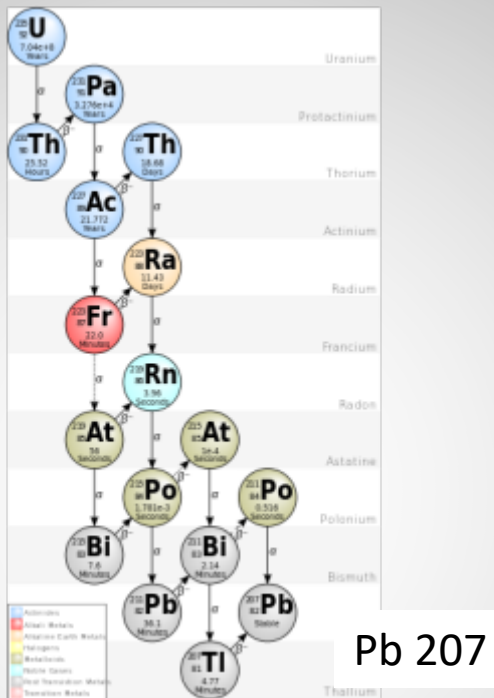
All lead are a mixture of isotopes derived from Uranium and Thorium (except Pb-204) Lead and tin have similar chemical properties in table group 14.

Lead – It comes from Uranium & Thorium

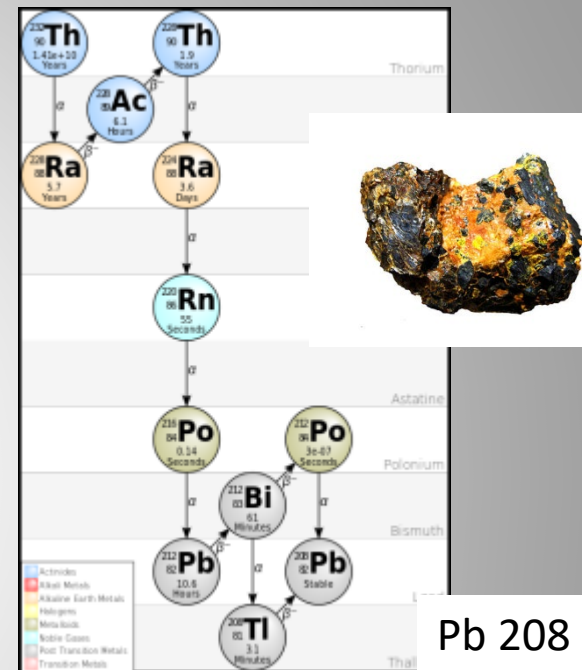
U-238 half-life 4.5e9y



U-235 half life 7.4e8y

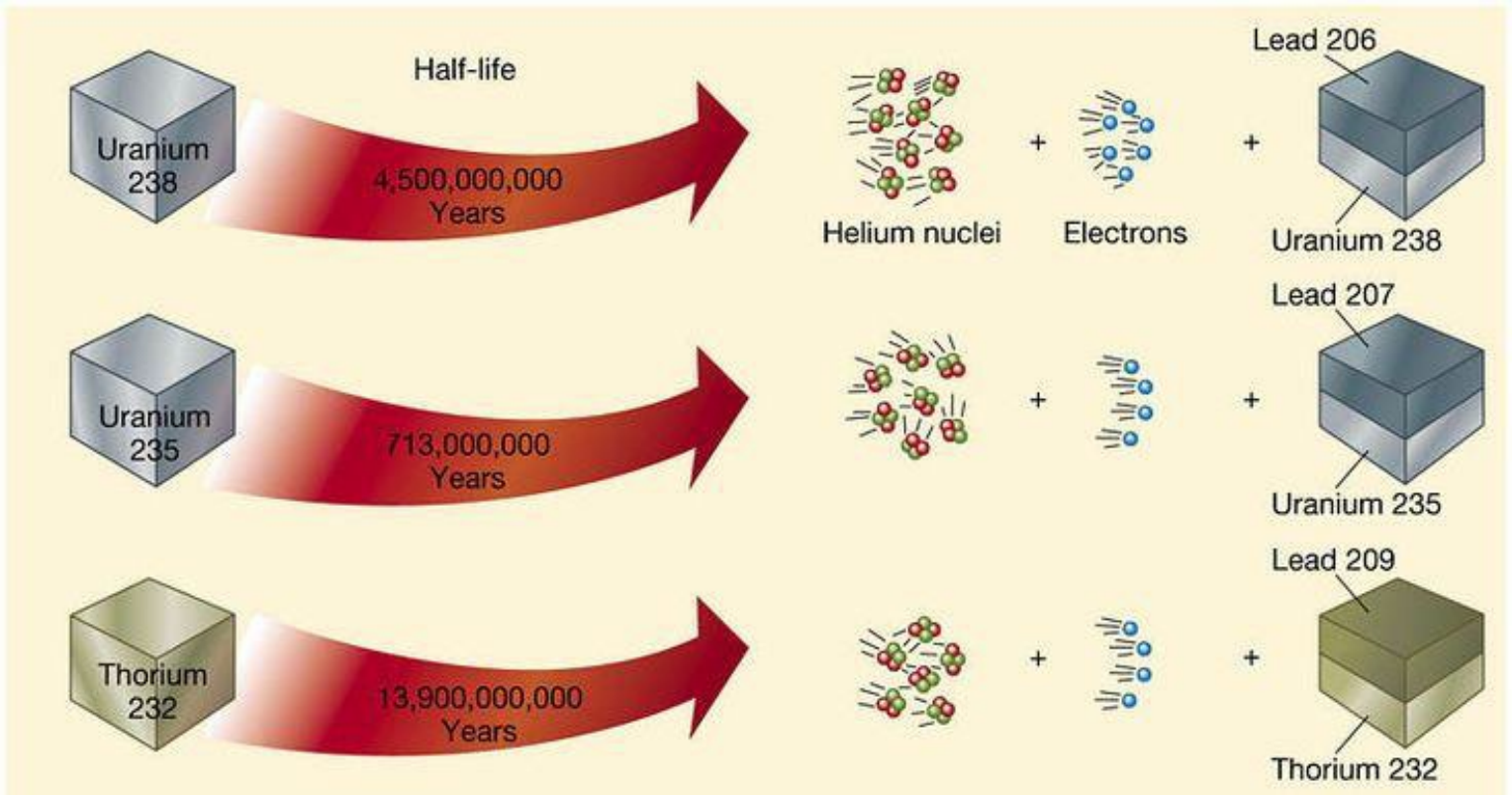


Th-232 half life 1.4e10y



Lead Isotope	Natural Abundance	Half-life
204 (all primordial)	1.4%	STABLE (mostly)
206 from U-238	24.1%	STABLE
207 from U-235	22.1%	STABLE
208 from Th-232	52.4%	STABLE

Lead – There's more today than yesterday

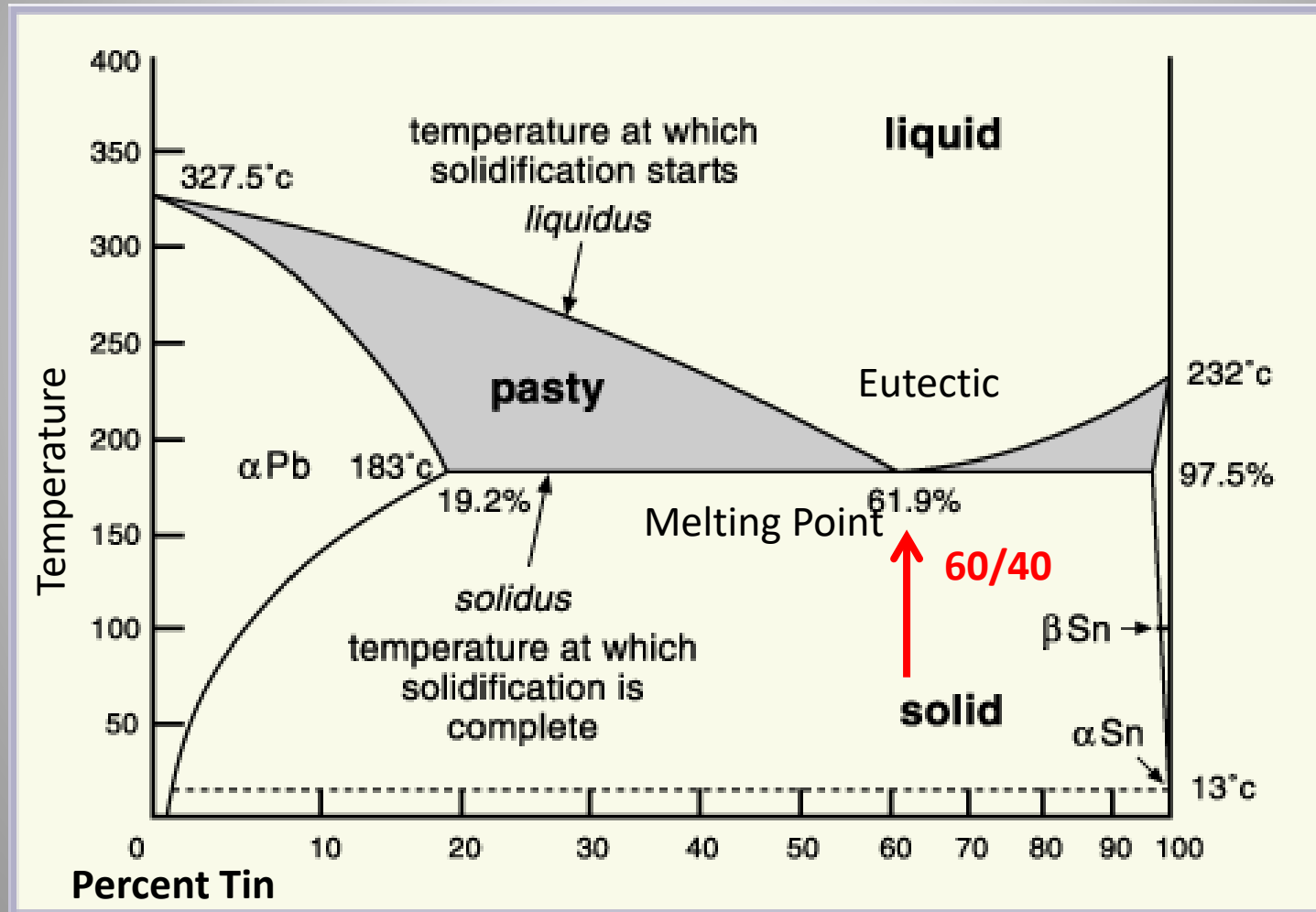


Lead Alloys – Why 60/40?

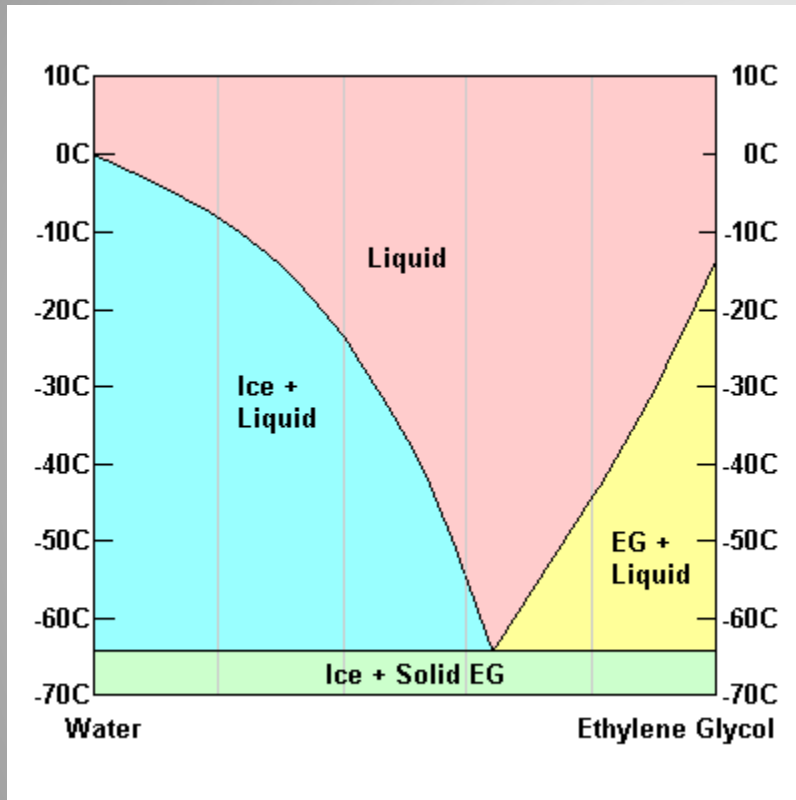
- **60% tin and 40% lead**
- 60/40 solder is the composition that will melt at the lowest possible temperature.
- Electron bonds are weakest causing the alloy to melt at the temperature of 183 degrees C.
- Lower temperature than the metals individually.

Lead-Tin Phase Diagram

Lead acts as the “impurity” that reduces the forces holding the tin atoms together, resulting in the lowering of the melting point.



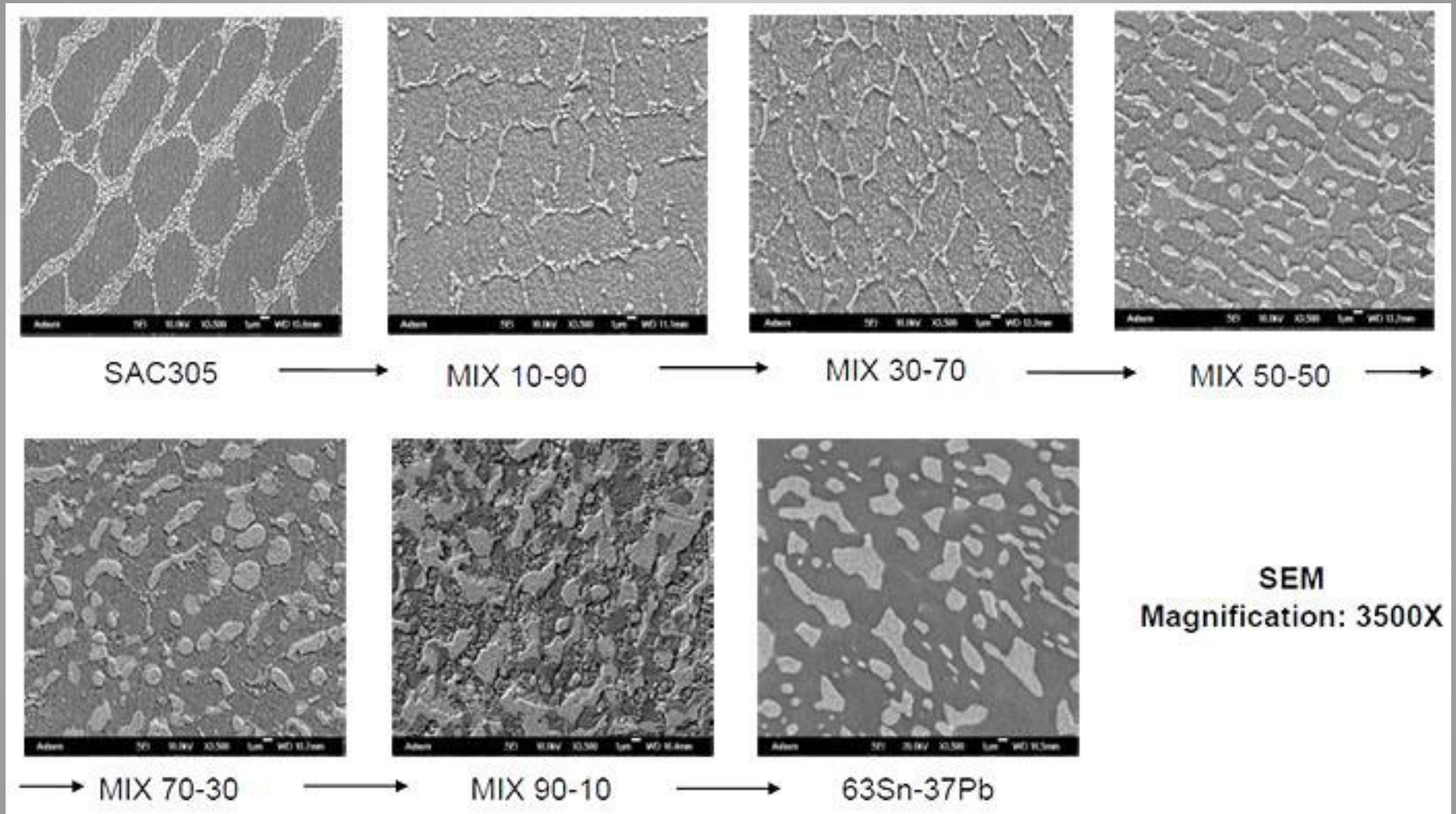
Antifreeze Phase Diagram



A familiar eutectic mixture is water and ethylene glycol (antifreeze). Ice melts at 0 C and ethylene glycol at about -14, but a suitable mixture stays liquid below -50C.

So if it's -20C outside and you decide to put in antifreeze, it's not frozen solid in the jug. Why not? Because it's diluted with water enough to have a very low freezing point. But the mixture is still to the right of the eutectic. If it were to the left, putting it in your radiator would dilute it too much to yield a suitably low freezing point.

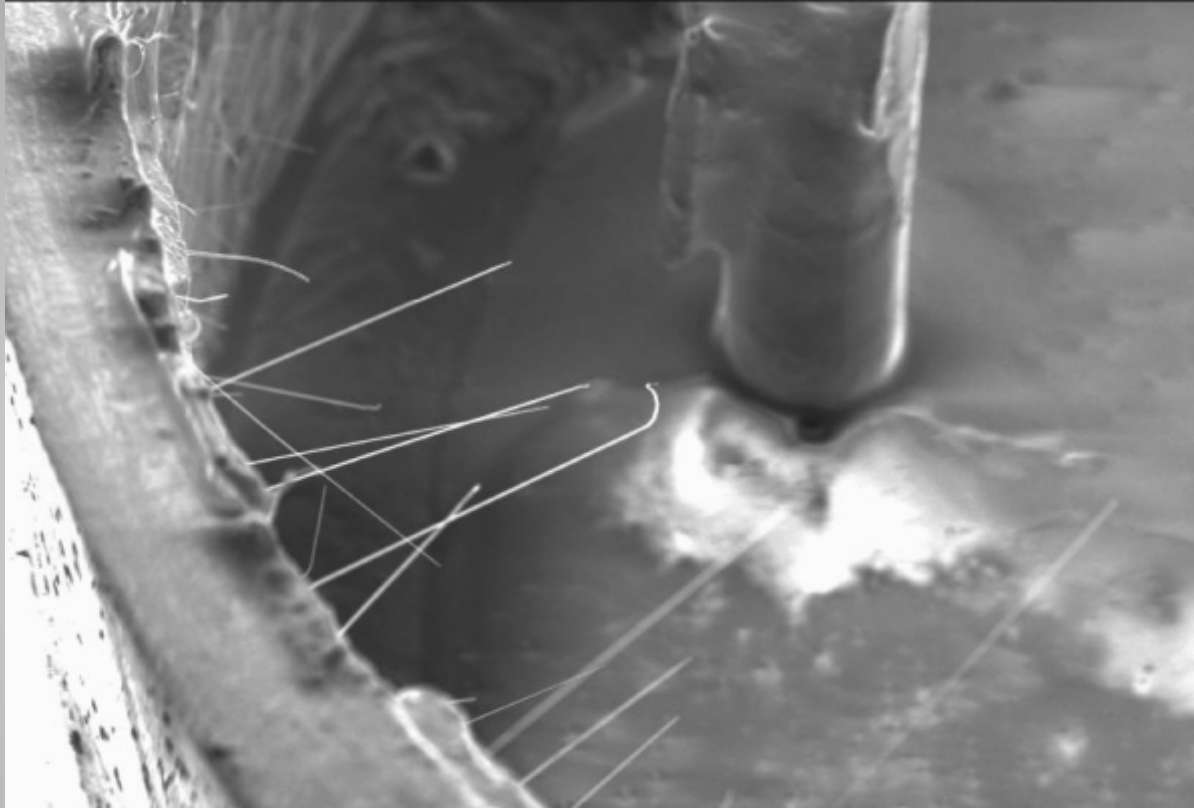
Effects of Lead/Tin Mixture on Texture



Because one metal crystallizes first, crystal grains appear to grow and are cemented by the metal that solidifies last. This is reflected in the microstructure.

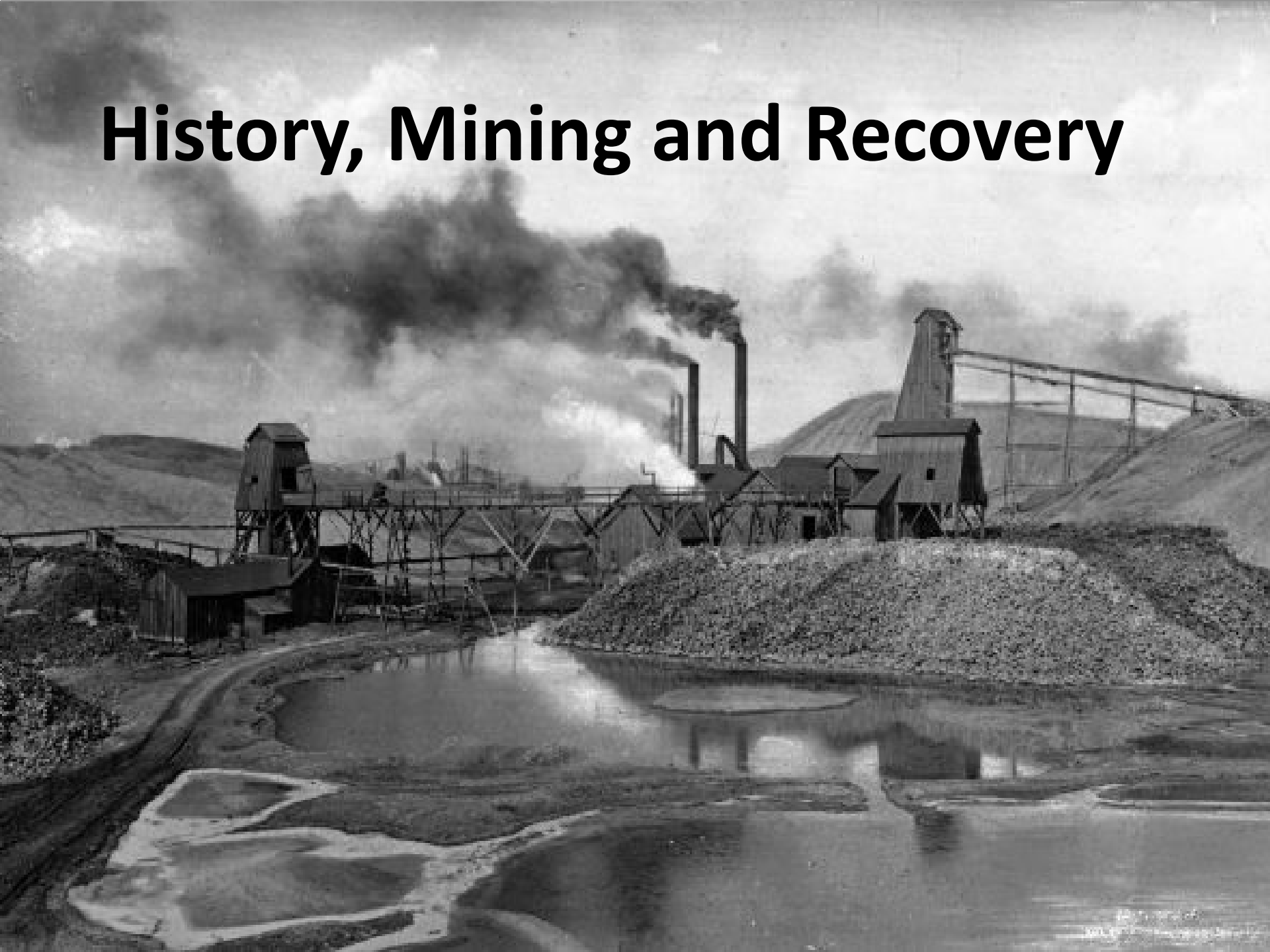
Low Lead Solder – It has problems...

Tin Whisker – bad for circuits



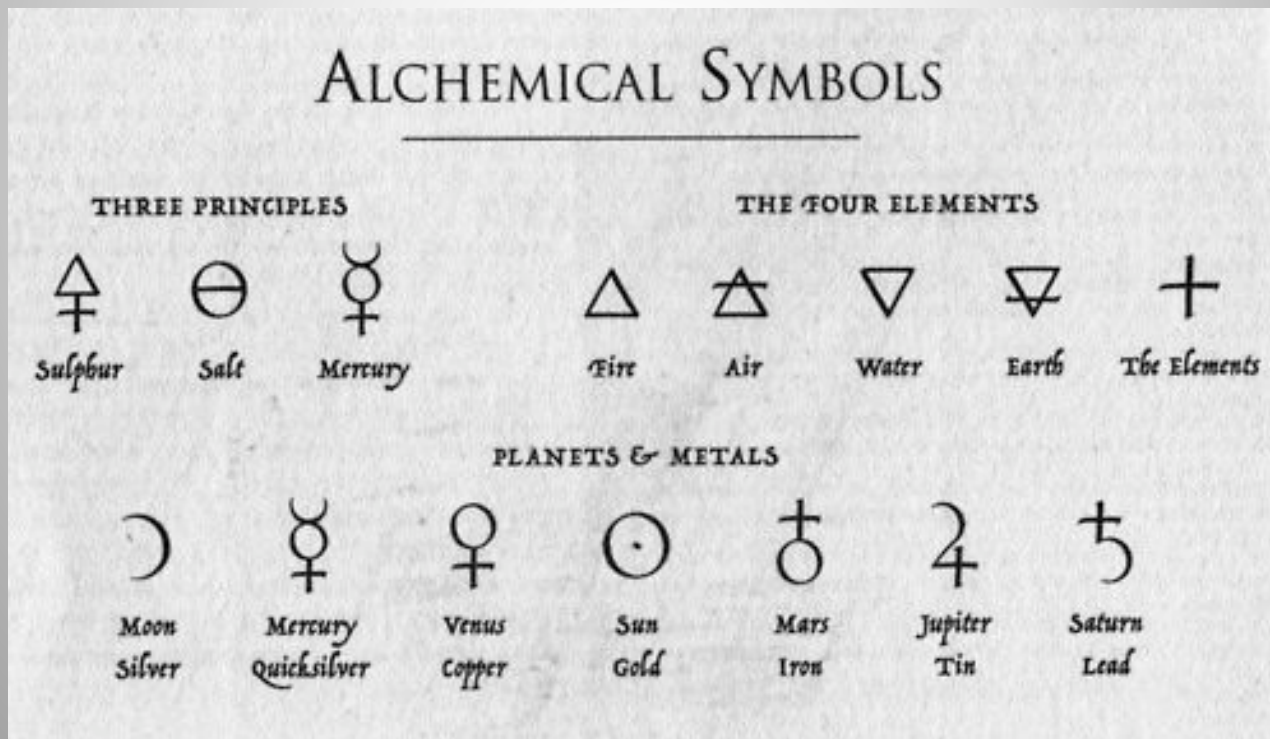
Low-lead solder can recrystallize from thermal and mechanical stress causing whisker growth that can cause circuit failure. Zinc, lead, tin, silver can have this problem. Newer alloys tend to avoid this problem but its still an issue.

History, Mining and Recovery



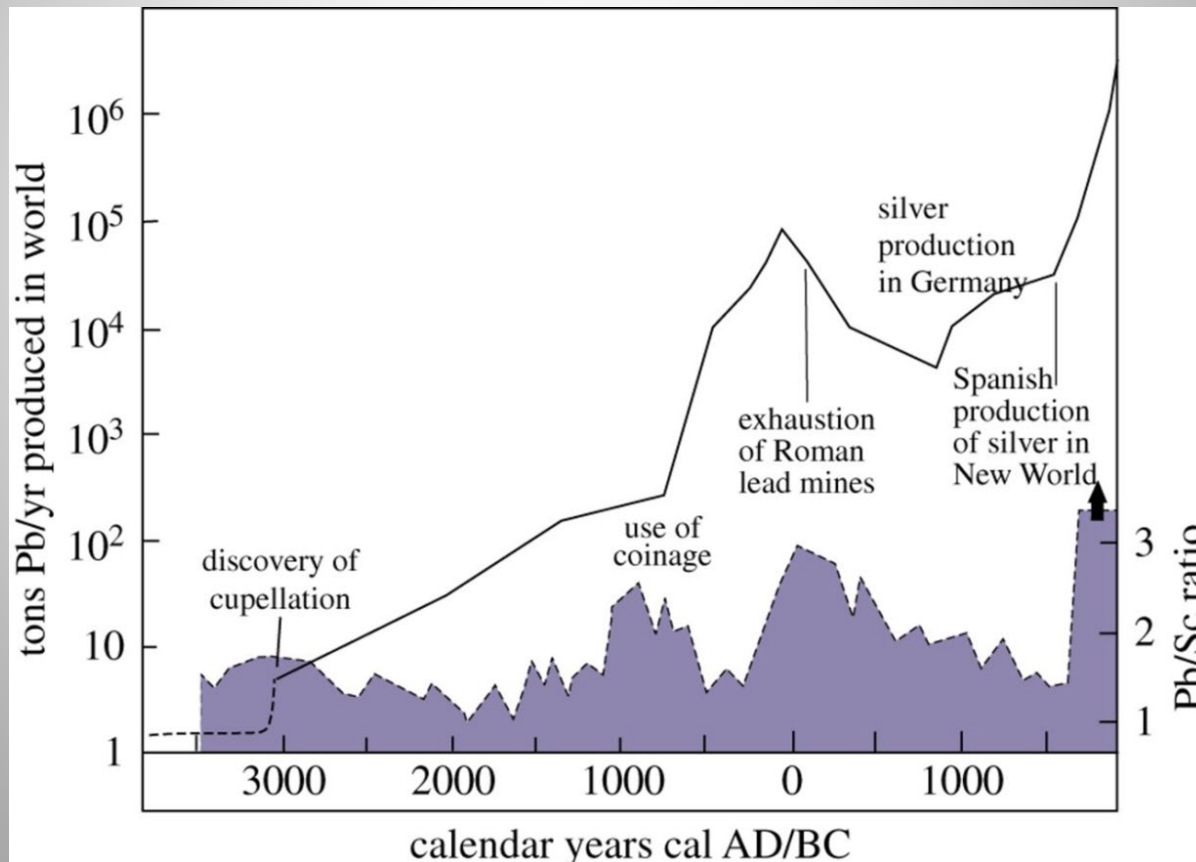
Sol-der – Early 14th Century

Middle English: from Old French *soudure*, from the verb *souder*, from Latin *solidare* 'fasten together,' from *solidus* 'solid.' Lead and Tin known From Antiquity.

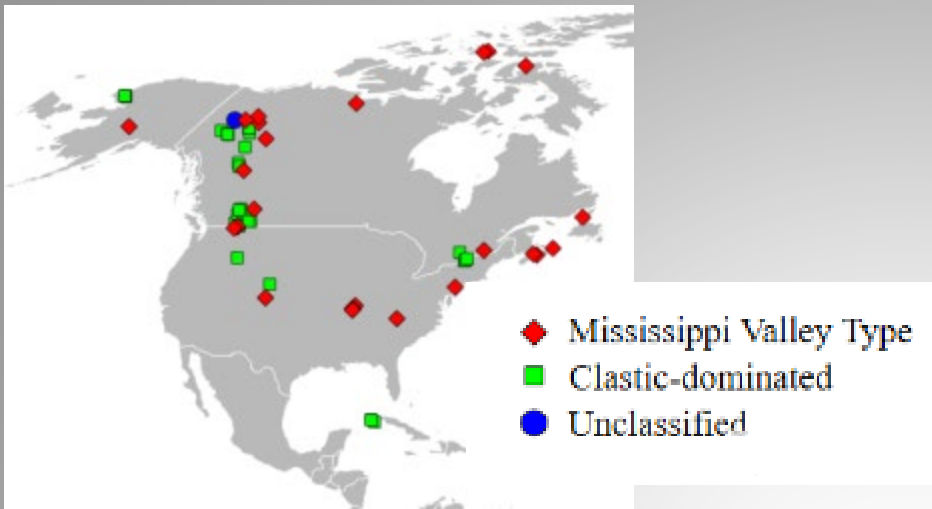


Lead Pb (Plumbum)

Original Germanic origin. Related to Dutch *leiden* or *leiten*, also to *load* and *lode*. *Plumbum* is Latin that gives the name to the chemical element. Origin of the craft name *plumber*.



Lead Mining



Ores: Disseminated or massive veins or masses of lead sulfide or oxide with zinc, silver and quartz.



Galena – Lead Sulfide



Open Pit

Hot brine leach metals from rocks which are then deposited in favorable zones as ores.

Processing and Waste



Specimen Galena Ore



Asarco El Paso: Ores roasted to drive off sulfur and smelted.

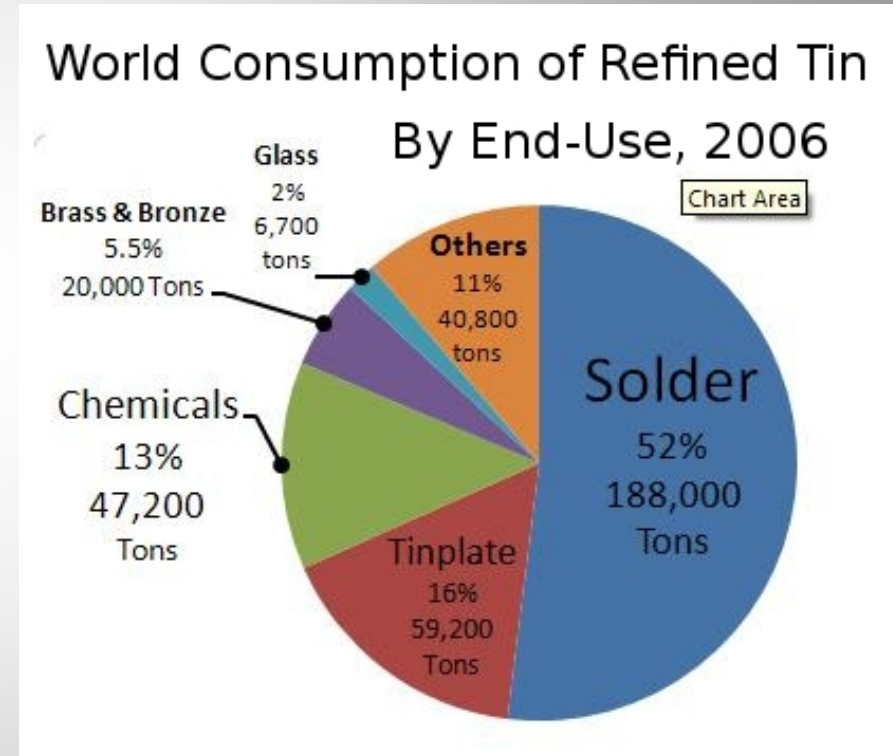


“chat” - silica waste left over after removal of Pb/Zn ore – Picher, Oklahoma

Tin Sn (Stannum)

Known from Antiquity

Dated to the Bronze Age – 3000 BC
Alloyed with copper to form bronze
Alloyed with silver to form pewter
Cassiterides – (Greek) mythical islands where tin originated.
Proto-German in origin with the common name Tin is Dutch.
Stannum (Latin) (Stannite) possibly Cornish.



Tin – The Largest Component of Solder 60%

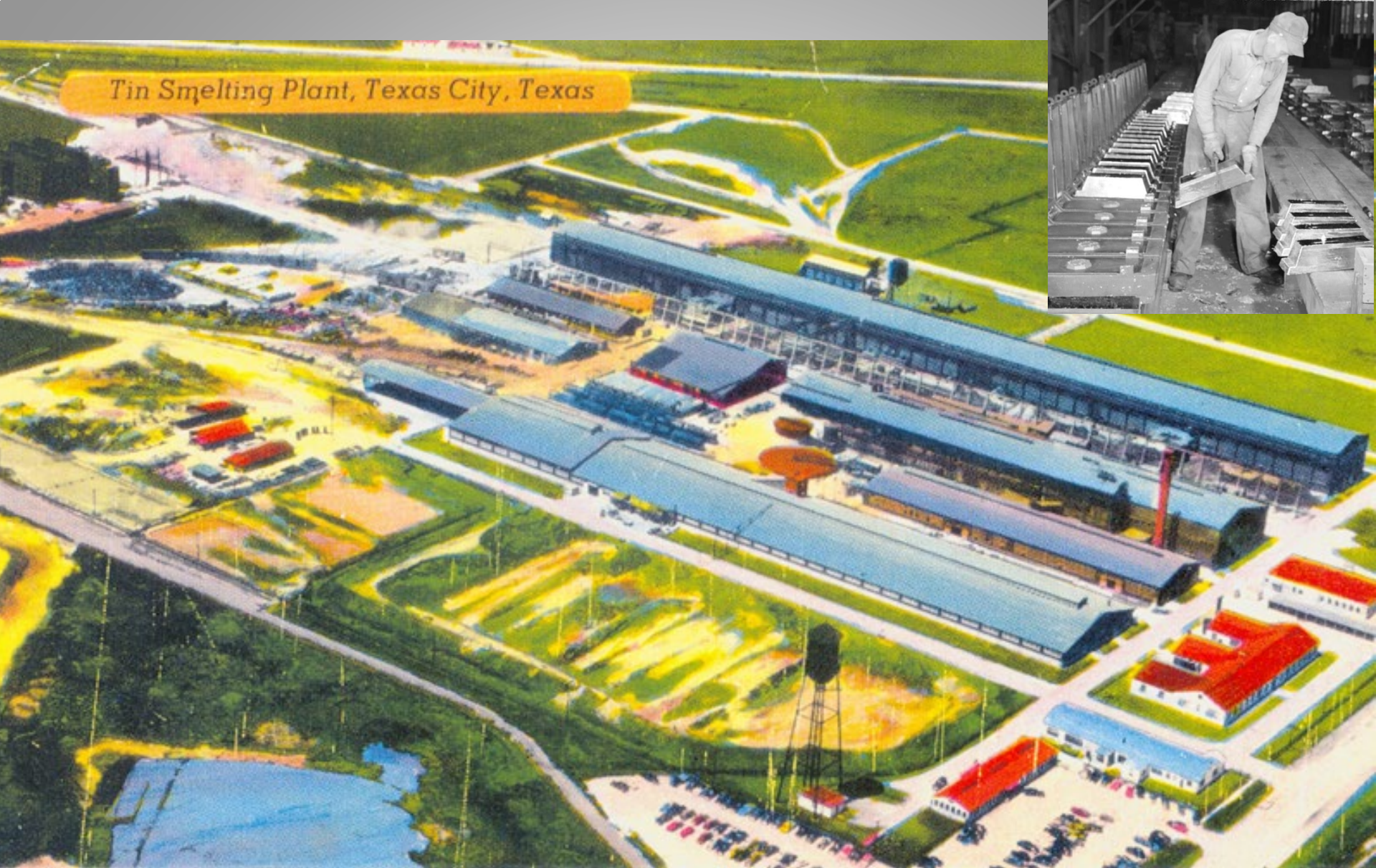
Disseminated ore in granite



Tin dredging



Crushed ore



The Longhorn Smelter was the only tin smelter in the United States during WWII. 1940-1982.

Now the former Tex Tin Superfund Site.



th
US

100 ft

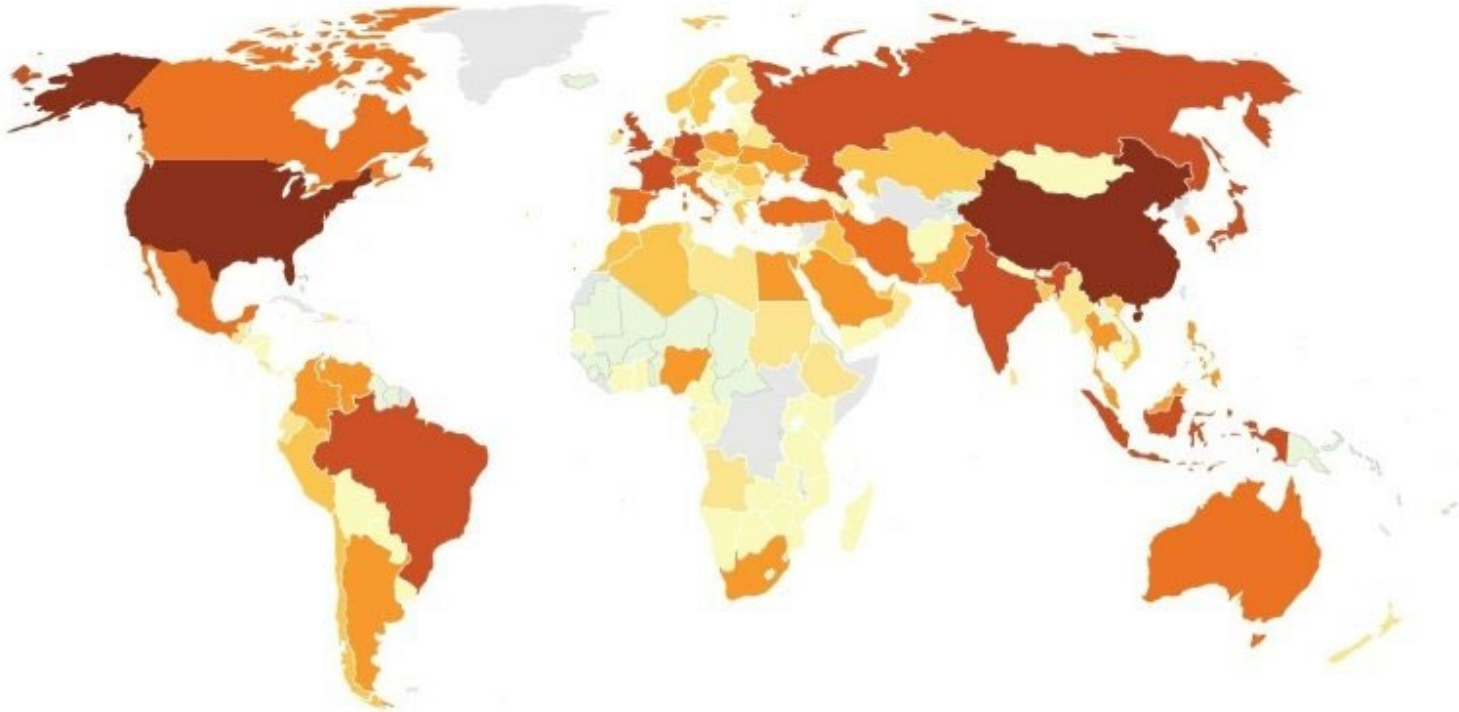


The Legacy



Electronic waste

E-waste generated in kilotonnes, 2016



Worst polluters

CHINA	US	JAPAN	INDIA	GERMANY	UK
7,211	6,295	2,139	1,975	1,884	1,632

Source: ewastemonitor.info

© AFP

