
SILVER
SOLDERING
A to Z

Part One

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- GIA Video
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- Variations in Manufacturing Standards
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- Preparing Your Solder
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- Heating the Work Evenly
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- 3 Important Facts to Remember
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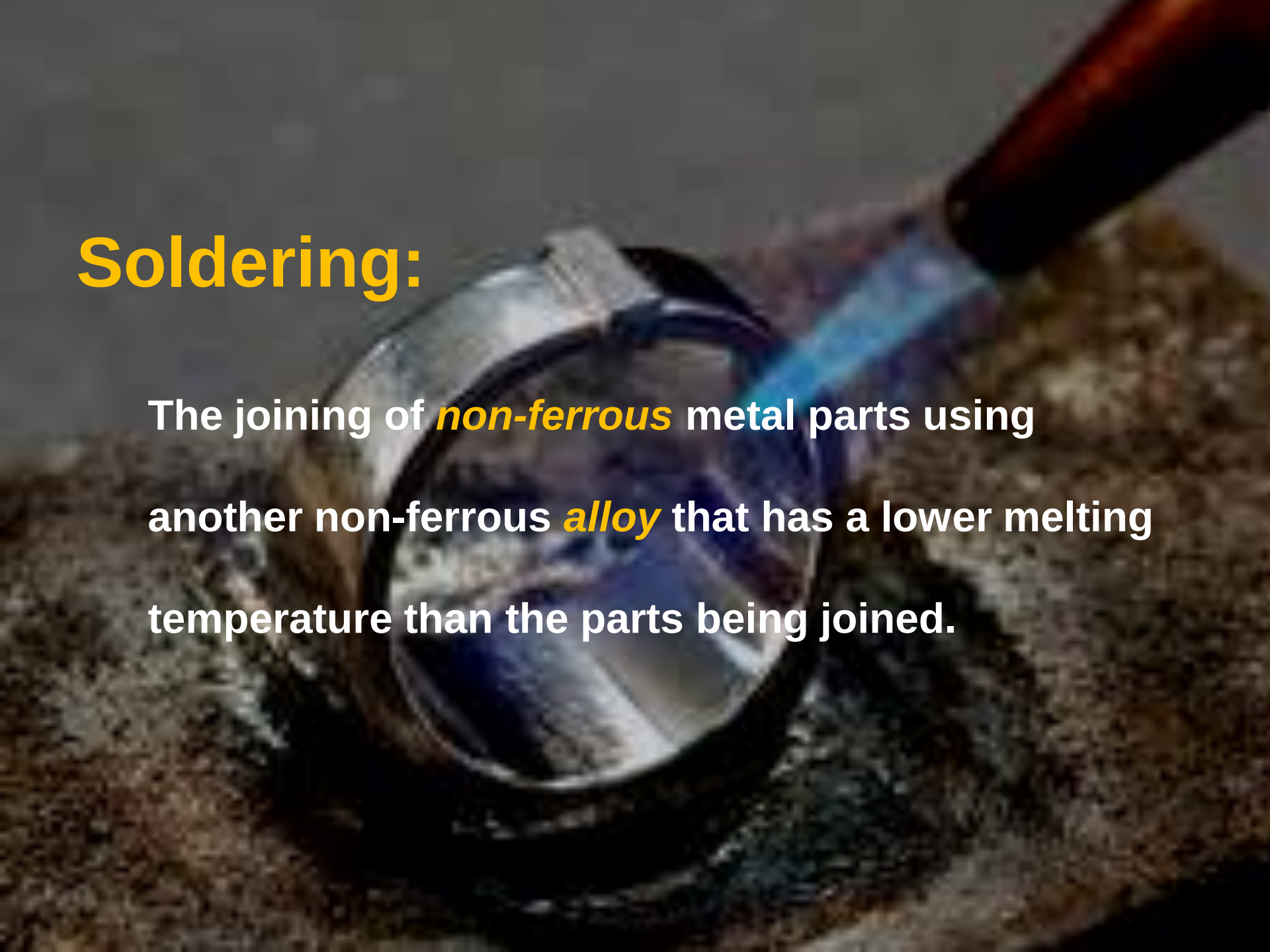
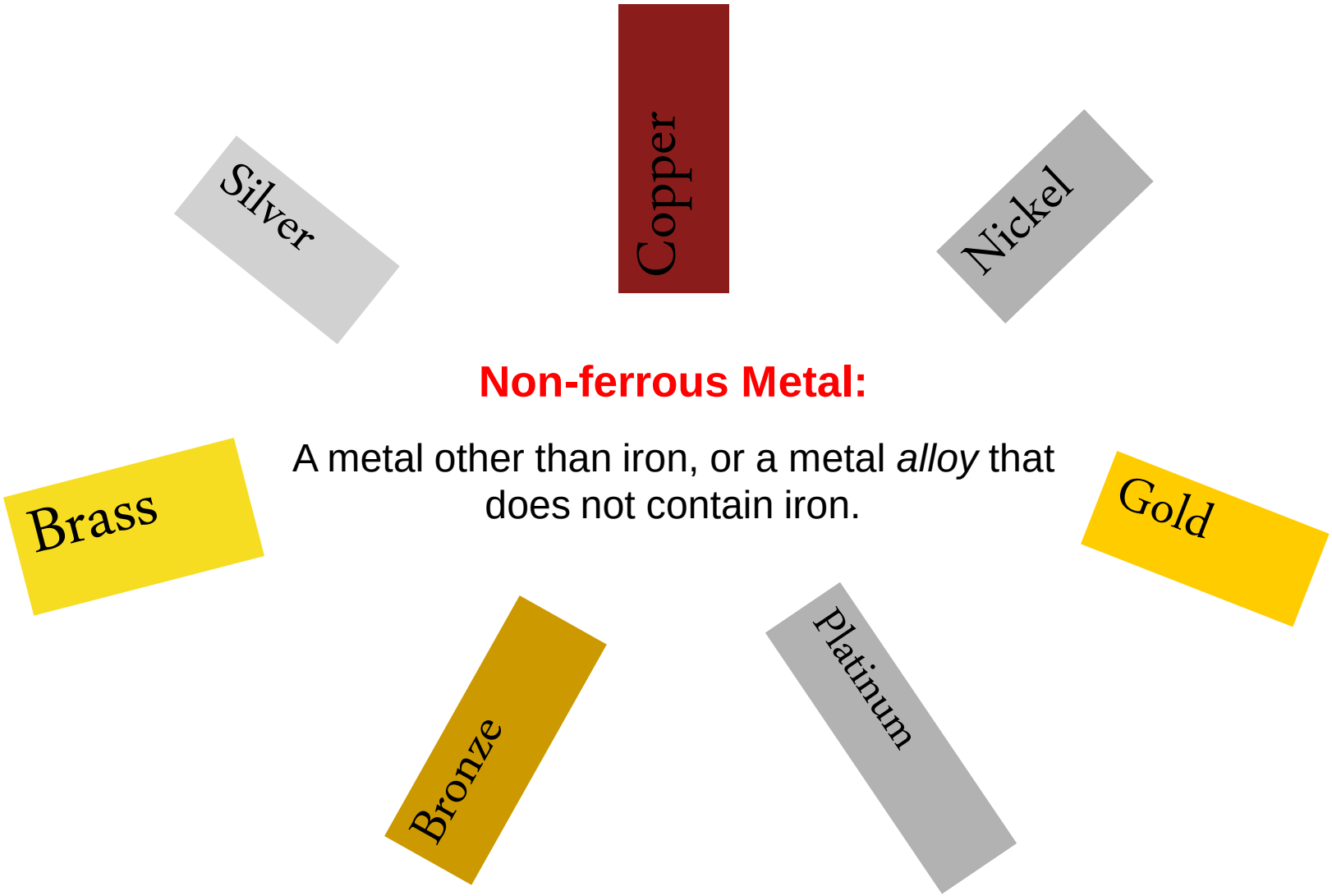


Soldering:

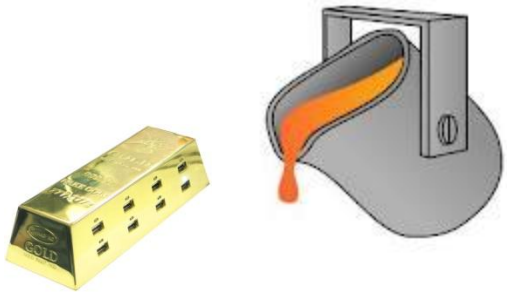
The joining of *non-ferrous* metal parts using another non-ferrous *alloy* that has a lower melting temperature than the parts being joined.



Non-ferrous Metal:

A metal other than iron, or a metal *alloy* that does not contain iron.

With the exception of platinum, it is easy to solder any of the above metals with silver solder or gold solder



Alloy: A mixture of one or more metallic elements

Examples:
Pure silver + pure copper = sterling silver
Pure silver + germanium = argentium sterling silver

Alloys often have physical properties markedly different from those of the pure metals they are made of.

There are 2 General

CLASSIFICATIONS

for types of soldering:

Soft Soldering & Hard Soldering

Vs.

Soft Solder:

- Melts below 700 º F.
- Makes a weak joint (no diffusion)
- Typically made of lead, tin, and antimony. (Like solders used in electronics)
- Melted with a soldering iron, usually *not* a torch
- **Not generally used in jewelry making or metalsmithing (Except in rare repair processes).**
- Will contaminate work surfaces and cause serious pitting in precious metals

Hard Solder & Hard Soldering (Silver Soldering or Gold Soldering):

- Melts above 900 º F
- Makes a strong joint (diffusion takes place on molecular level)
- Utilizes a solder alloy made up of the main metal it is meant to join

Example: Silver solder has mostly silver in it, plus a small percentage of other metals (usually copper, zinc and sometimes tin).

=

Silver

\+

Copper

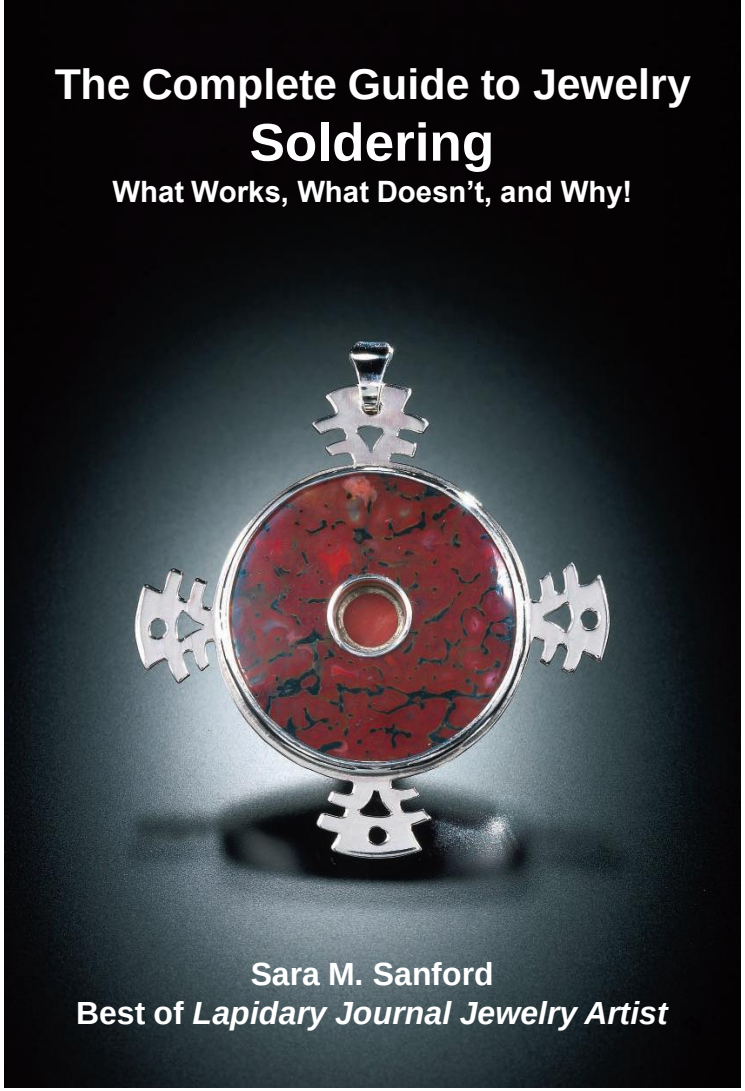
\+

Zinc

Silver solder, however, can also be used to join other non-ferrous metals such as copper, brass, nickel silver, bronze and gold.

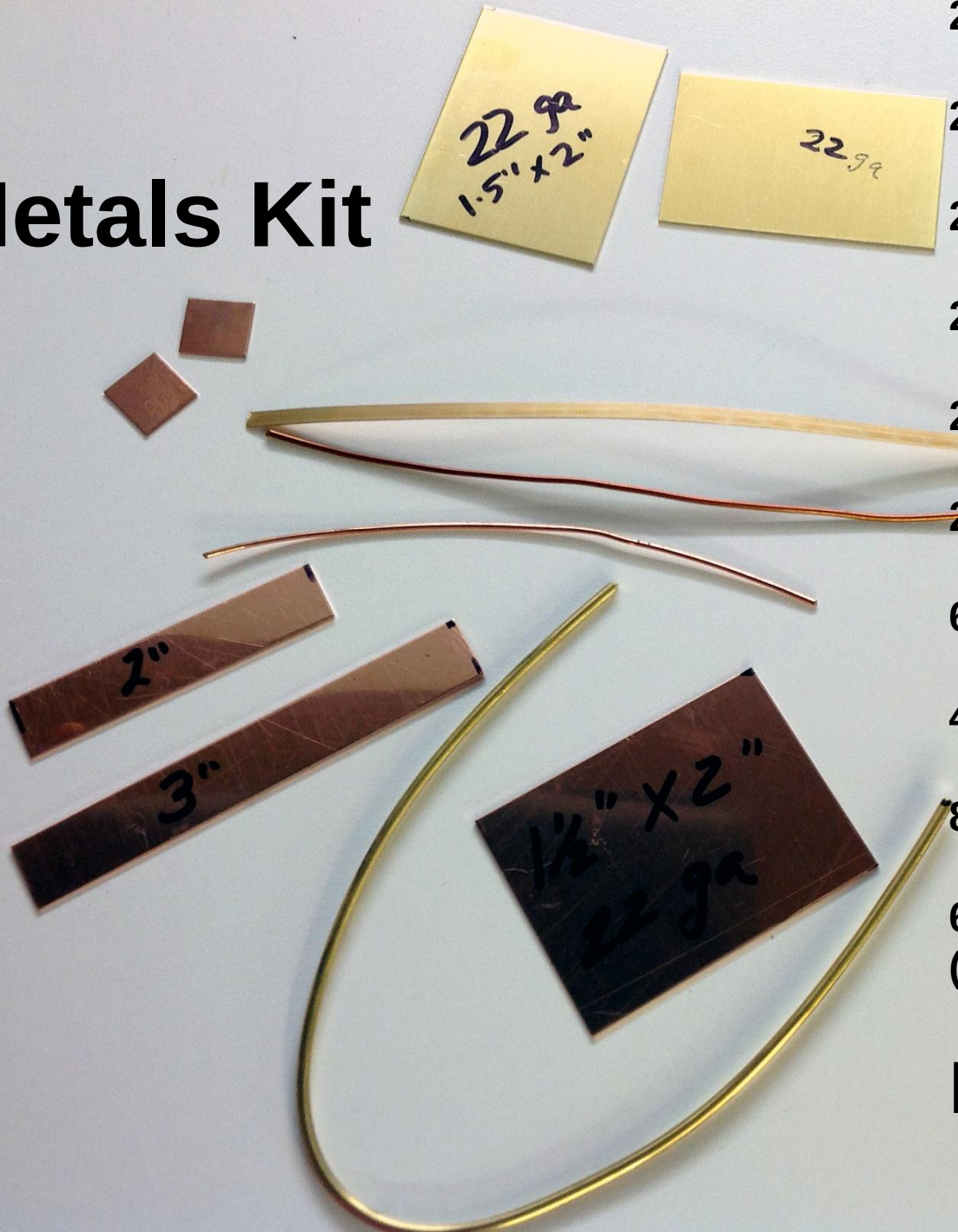
- The term, silver *soldering,* is a misnomer because the process is actually ***brazing.***

- In brazing -- and therefore in silver soldering -- there is a *diffusion exchange* between the metal parts being joined and the filler metal, also called the brazing alloy (i.e., the solder).



The Complete Guide to Jewelry Soldering
By Sara M. Sanford
$10.50 Digital book available online at:
http://www.interweavestore.com/complete-guide-to-jewelry-soldering-ebook

Metals Kit



22 Ga Brass Sheet 1.5” X 2”

22 Ga Brass Sheet 1.25” X 2”

22 Ga Copper Sheet 1.5” X 2”

21/22 Ga Copper Sheet 3” X .5”

21/22 Ga Copper Sheet 2” X .5”

23 Ga .5” X.5” (Two)

6” 17Ga Round Copper Wire

4” 18Ga Round Copper Wire

8” 12Ga Round Brass Wire

6” Brass Bezel Wire 28 Ga (.0125”) X1/8”

Kit Price $2.75

Solder Kit

$6.50 for 1 Square inch of all four grades of solder

Rio Grande/GIA Video on Soldering

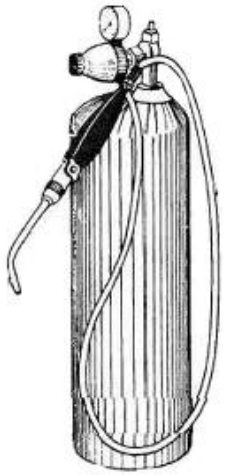
http://www.youtube.com/watch?feature=player_embedded&v=-M-v_cj8mNw

Soldering 101 - What is Jewelry Soldering, Anyway.mp4

- Hard soldering (silver soldering) is the type of soldering that jewelers and metalsmiths do

  (gold soldering is also a form of hard soldering)

- Silver soldering cannot be done with a soldering *gun*; it requires a torch.



Silver solders come in 4 basic forms:

Sheet

Most commonly used

Wire

Chip

Not recommended to buy in this form; you can make your own chips, also called *pallions*

Paste

Mostly used for repairs And machine soldering

- **Silver solders are graded by their melting temperatures**
- **Most are Ternary alloys (have 3 components – silver, copper and zinc)**
- **The more zinc,** the lower the melting point and the more yellow the silver solder will be
- **The lower the melting point,** the weaker and more brittle the bond

Grades of solder:

(divided according to melting temperature)

- IT (Extra Hard) Highest melting temp; can be used in enameling but not where it will touch enamel directly (contains zinc)
- Eutectic Next highest melting point; Has a single melt/flow temperature of around 1435 º F, is a binary alloy (contains only silver -72% and copper -28%); also used in enameling because it can be used in contact with enamel
- Hard Third highest melting point and most commonly used in first soldering operations, and where strong joints are required, and/or where best color match is required
- Medium* Used for intermediate soldering operations
- Easy Lower melting point than Medium; Used for final soldering operations or when high heat should be avoided; often used for soldering findings
- Extra Easy Lowest melting point; Used for repairs and where high heat must be avoided and solder color and strength is not a major issue

(*Hoover & Strong offers a Medium-Hard grade of silver solder)

Non-eutectic Silver Solder has two main temperature characteristics:

- **Melting point**
- metal is *beginning* to melt
- it is slushy or like a slurry; solid and liquid at the same time
- can be moved around but doesn't really flow
- This state is also called *solidus*

- **Flow point**
- usually 100 degrees or so hotter than melting point
- metal is truly liquid and flows freely
- This state is also called *liquidus*

Melt Point =
Solidus state

Flow Point =
Liquidus state

- There is no standard temperature range for hard solders

  You will find wide temperature variations from one manufacturer to the next

Comparison Chart – Rio Grande vs. Hoover & Strong Silver Solders

Rio Grande

Contents in % Ag	Cu	Zn	Sn	Cd	Melt º F	Flow º F	Rio Grande's Silver Solders
80	?	?	n/a	n/a	1370	1490	Ex-Hard
75	20-22	3-15	n/a	n/a	1365	1450	Hard
70	20-22	3-15	n/a	n/a	1275	1360	Medium
65	20-22	3-15	n/a	n/a	1240	1325	Easy
56	14-32	4.5-28	1.5-5	n/a	1145	1207	Ex-Easy

Hoover & Strong

Hoover & Strong Silver Solders	Melt º F	Flow º F	Contents in % Ag	Cu	Zn	Cd
Hard	1370	1490	80-90	15-20	3-5	n/a
Med-Hard	1330	1375	75	?	?	n/a
Medium	1265	1295	45-65	20-25	15-20	n/a
Soft	1235	1260	45-60	20-40	15-30	n/a
Ex-Soft	1170	1190	20-40	20-40	15-20	15-20

Ag = silver; Cu = copper; Zn = zinc; Sn = tin; Cd = cadmium

Comparison of Metal Melt Points to Solder Melt Points

Note: Melting point of Rio Hard Solder is only 25 degrees lower than the solidus melt point of sterling silver.

Metal	Melt Point	Composition
Platinum	3224	.995 Pt
Nickel Silver (German Silver)	2030	2030 65 Cu 17 Zn 18 Ni
Copper	1981	99.9 Cu
Fine Gold	1950	99.9 Au
Red Brass (Merlin's Gold)	1877	85 Cu 15 Zn
14K White	1825	58.33Au 22.1Cu 10.8 Ni 8.77 Zn
Fine Silver	**1761°F**	**99.9% Ag**
18 Kt Yellow	1620-1715	75% Au 15 Ag 10 Cu
Yellow Brass	1706	70 Cu 30 Zn
Sterling Silver	**Solidus: 1475°F Liquidus: 1640°F**	**92.5% Ag 7.5 Cu**
14K Yellow	1615	58.33 Au 8.3 Ag 29.2 Cu 4.17 Zn
Zinc	787	99.9 Zn
Tin	450	99.9 Sn

Rio Grande Solders	Melt ° F	Flow ° F	Contents in % Ag	Cu	Zn	SN	Cd
Ex Hard	1370	1490	80	?	n/a		n/a
Hard	**1365°F**	**1450°F**	**75**	**20-22**	**3-15**	**n/a**	**n/a**
Medium	**1275**	**1360**	70	20-22	3-15	n/a	n/a
Easy	**1240**	**1325**	65	20-22	3-15	n/a	n/a
Ex Easy	**1145**	**1207**	56	14-32	4.5-28	1.5-5	n/a

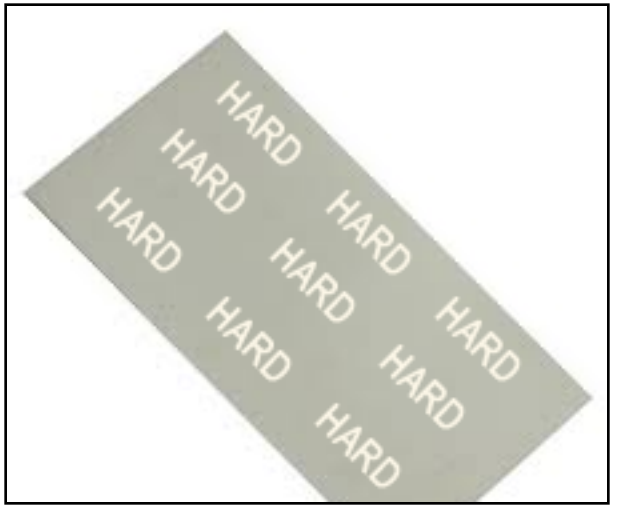
Preparing Your Solder

- **Make note of the melt and flow points of your solders**
- Mark your solder!
- Keep solders separate!
- Label your containers!

Hoover and Strong
Hard Silver Solder
H8-80
Melts at: 1370
Flows at: 1490

To insure you never mix up your solders…..

Mark your solder with a steel scriber



And

Color code your solder with Sharpee Markers

Keep your solder clean

- Use Tarnex to remove tarnish
- Pickle to remove oils and other contaminates
- Store in a dry, sealed container
- Do not cut up more than you will use for your current project

Must-Have Tools & Supplies for Soldering

Titanium solder picks

White Out/Correction Fluid

Small, round paint brush (#00) with pointed tip (soft bristles are best)

Video by Nancy Hamilton
All About Solder

http://www.youtube.com/watch?v=zZZY-bUkiA4

Video time: 8:16

All About Solder _ Jewelry Tips with Nancy.mp4

Remember These Important Facts About Soldering

1. **A Tight Fit is Imperative**
2. **All Surfaces Must be Clean and free of oxidation**
3. **Flux All Parts *and* the Solder**
4. **Choose the right solder type for the job**
5. **Use no more solder than necessary**
6. **Heat the entire piece first, then the joint area**

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Fitting your parts

Solder works by capillary action, therefore it flows into tight crevices but it does *not* like to fill voids or gaps!

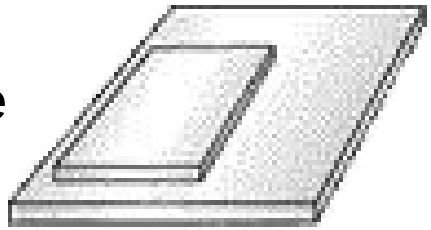
- Insure the best possible fit with no gap between parts – make it *"light tight"*
- When possible, notch wires and peg small parts to increase contact area; the more surface contact, the stronger the joint
- The tighter the fit, the less the joint will show and the less seam porosity you will have

Main Types of Solder Joints

Butt Joint

Soldering two pieces of metal together - edge to edge

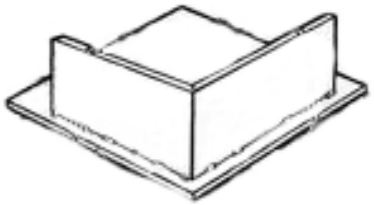
Sweat Joint



Soldering two flat pieces of metal together – plane one on top of the other

T- Joint

Soldering two pieces of metal together in a horizontal to vertical juxtaposition



Butt, Lap and Scarf Joint Examples

from Jewelry Concepts and Technology by Oppi Untracht

BASIC TYPES OF JOINTS

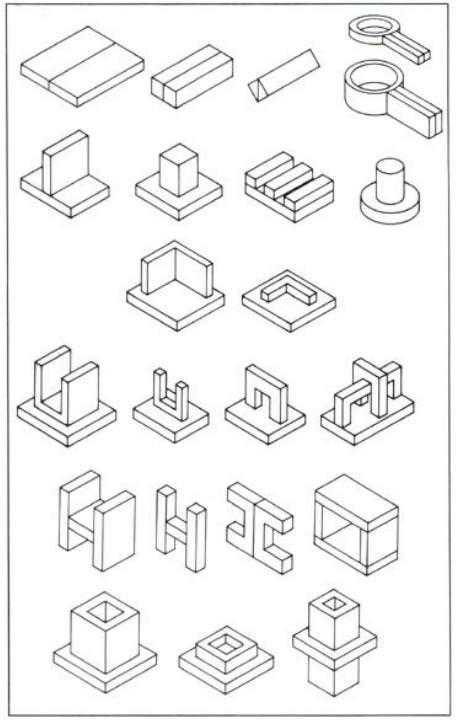
A *joint* is a place where two or more parts are united or made to fit together. The union can be permanent as when soldering, riveting, or welding, or movable as in other joining methods such as certain kinds of riveting, screwing, flanging, folding, and bending.

BUTT JOINTS In a butt joint, two ends come together squarely at their extremity without scarfing or chamfering.

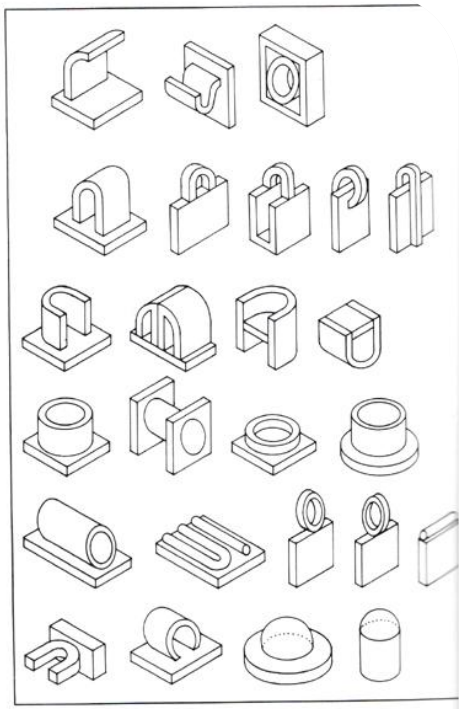
LAP JOINTS In a lap joint, one part or layer overlaps another. A special type is a *sleeve joint* in which one tube fits inside another.

SCARF JOINTS In a scarf joint, the join is made by chamfering, beveling, notching, halving, or otherwise cutting the two parts so that they correspond with each other where they overlap. Such joints can also be made by the use of a *plate* that overlaps the joint and is secured by rivets.

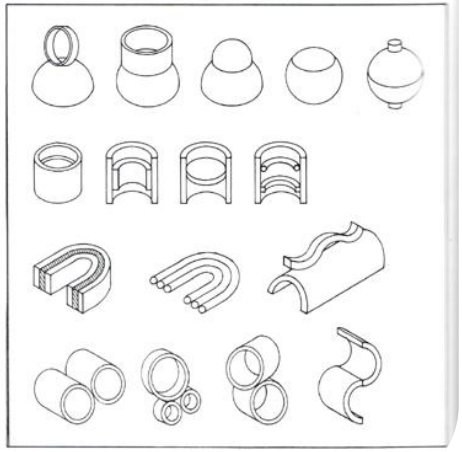
All the joints shown here are made with the basic forms of metal used by the jeweler: sheet, wire, and tubing. Many of the situations illustrated can also be used when joining or assembling cast sections, or when combining cast and fabricated parts. In some cases, solder would not be needed, though it could be used. We do not include all conceivable combinations, as this is obviously impossible.



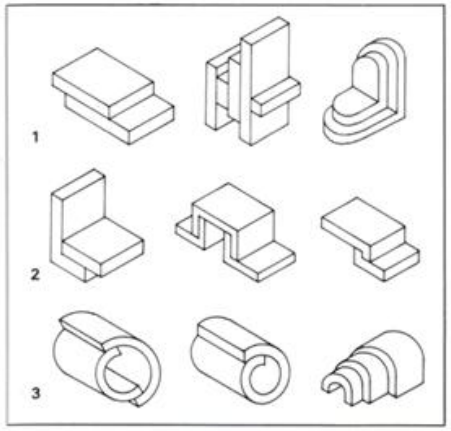
10–3 *BUTT JOINTS, FLAT TO FLAT.*



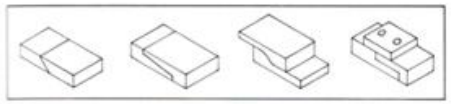
10–4 *BUTT JOINTS, CURVE TO FLAT.*



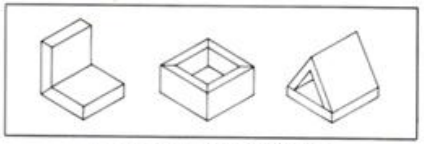
10–5 *BUTT JOINTS, CURVE TO CURVE.*



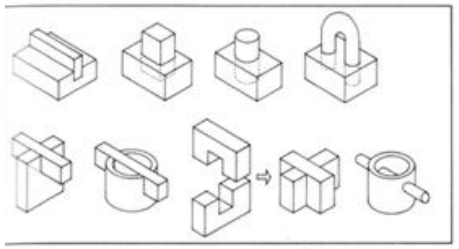
10–6 *LAP JOINTS. 1. Flat to flat; 2. Corner lap; 3. Curve to curve.*



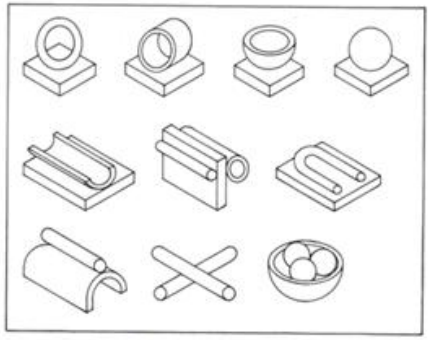
10–7 *SCARF JOINTS.*



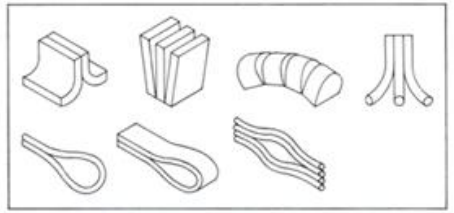
10–8 *CHAMFERED OR BEVELED JOINTS.*



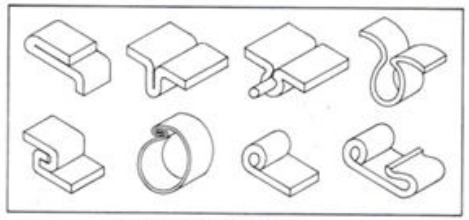
10–9 *SLOT AND PENETRATION JOINTS.*



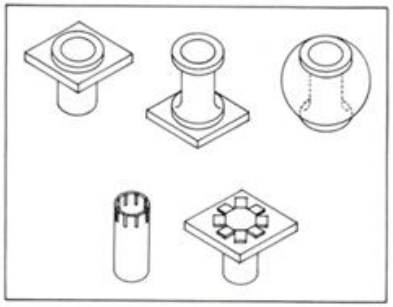
10–10 *POINT- OR LINE-OF-CONTACT JOINTS.*



10–11 *SPREAD GAP JOINTS*
This consists of the joining of two forms only by their contacting edges or surfaces, their physical shape making larger surface contact impossible.



10–12 *BEND AND FOLD JOINTS.*



10–13 *FLANGED JOINTS.*

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There are two ways to clean your metal:

- **Mechanical Cleaning**
- **Chemical Cleaning**

Mechanical Cleaning:

Any *“mechanical”* process that removes a fine layer of metal, as with a tool or abrasive material that exposes fresh metal and thereby removes any dirt or oxidation that may have been on the surface initially.

Examples: Sanding, filing, grinding, scraping, brass brushing

Note About Using Steel Wool:

You can use steel wool as an abrasive to clean you metal. However, it leaves loose bits of steel and oil on the surface of your metal and this must be washed off.

No steel wool in the “pickle pot” -- It will contaminate the pickle!

Chemical Cleaning (Pickling):

- The use of an acidic solution to remove oxidation and fire scale, and to dissolve and clean away melted flux from metal surfaces.
- Commercially made, granular pickling salts (compounds made of sodium bisulfate) are safer, but mild forms of sulphuric or nitric acid can also be used.
- Eco friendly versions of pickle can be made from household ingredients such as vinegar and salt, citric acid, alum (used in making pickles)
- PH reducer for swimming pools is the same as commercial pickling solutions (sodium bisulfate)
- See Charles Lewton Brain's article on alternative pickle solutions: http://www.ganoksin.com/borisat/nenam/pickling-notes.htm

- Chemical pickling compounds are acidic and corrosive.
- Avoid breathing fumes and avoid skin contact.
- Steel tools stored nearby will rust if exposed to pickling fumes.
- Pickling solution will burn holes in your jeans and other cotton clothing.

No iron or steel in the pickle pot – period!

Other Forms of Cleaning:

- Solvents remove oil and grease
- Liquid dish detergent and a soft brass brush
- Ultra sonic cleaner also works well to remove oils, grease and polishing compounds

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FLUX

The purpose of flux is:

- To remove impurities from the solder site.
- To act as an oxygen inhibitor by forming a skin which acts as a barrier to air and prevents oxidation and scale which solder will not adhere to.
- To reduce surface tension and facilitate the solder “flow” by acting as a medium for the solder to flow in.

Flux also acts as a temperature indicator.

There are two primary types of flux:

Paste & Liquid

Paste Flux

- Is a pasty, water-based compound consisting mainly of some form of borax and boric acid.
- It is easy to find recipes on the internet for home-made paste flux using ingredients such as boric acid, potash, salt, borax, alcohol, etc.

Paste Flux Pros:

- Tenacious and lasts better than liquid flux during prolonged heating.
- Better than liquid flux at preventing fire scale.
- Very good indicator of temperature.

Cons:

- Stays opaque until all the liquid evaporates, making it difficult to see small pieces of solder.
- Bubbles violently if heated too fast, causing solder pieces to swim around or away from the solder joint area.
- Some have fluorides and require the best ventilation possible (use a particulate soldering respirator if you do not have ventilation (available from Rio Grande, order# 201-683)

Contains No Flourides

Contains No Flourides

Contains Flourides

Contains Flourides (For Steel)

Paste Flux as Temperature Indicator

Temperature	Flux Color
Room Temperature	Opaque White
400-600 F	Fluffy Cloud White
1100 F	Clear, sometimes bluish-clear (indicates solder is close to melting)
Overheated	Red

Liquid Flux

- Most often used for soldering gold but can be used with other non-ferrous metals
- Can be mixed with paste flux

Liquid flux Pros:

- Stays clear
- Has broader temperature range
- Flows more easily into joints due to its thin viscosity and capillary action
- Self-pickling liquid fluxes actually remove light oxidation

Cons:

- Does not hold up as long or as well as paste flux
- Does not protect against fire scale as well as paste flux
- Thin viscosity encourages solder to float away from joint

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Choosing the Right

S 

lder

The solder you choose depends on a number of things:

- How many *joins* you anticipate,
- How you group your soldering operations
- The order you do them in
- How strong a join is necessary
- How thick/thin, bold/delicate the parts are
- And other considerations

Rio Grande Silver Solder

Supplied in sheet and wire
Cadmium Free

Rio Grande Solders	Melt º F	Flow º F	Recommended Use
Ex Hard	1370	1490	Sold only as 30 gauge wire for use in Laser welding machines; similar to IT solder
Hard	1365°F	1450°F	First joins of a complex fabrication; ring sizing, bezels
Medium	1275	1360	Intermediate solder joins in a complex fabrication; first joins on a simple fabrication
Easy	1240	1325	Last joins on a complex fabrication; findings, joining delicate parts
Ex Easy	1145	1207	Repair work; final joins on a very complex fabrication, joinging very delicate parts, findings

Comparison of Metal Melt Points to Solder Melt Points

Metal	Melt Point	Composition
Platinum	3224	.995 Pt
Nickel Silver (German Silver)	2030	2030 65 Cu 17 Zn 18 Ni
Copper	1981	99.9 Cu
Fine Gold	1950	99.9 Au
Red Brass (Merlin's Gold)	1877	85 Cu 15 Zn
14K White	1825	58.33Au 22.1Cu 10.8 Ni 8.77 Zn
Fine Silver	**1761°F**	**99.9% Ag**
18 Kt Yellow	1620-1715	75% Au 15 Ag 10 Cu
Yellow Brass	1706	70 Cu 30 Zn
Sterling Silver	**Solidus: 1475°F Liquidus: 1640°F**	**92.5% Ag 7.5 Cu**
14K Yellow	1615	58.33 Au 8.3 Ag 29.2 Cu 4.17 Zn
Zinc	787	99.9 Zn
Tin	450	99.9 Sn

Rio Grande Solders	Melt ° F	Flow ° F	Contents in % Ag	Cu	Zn	SN	Cd
Ex Hard	1370	1490	80	?	n/a		n/a
Hard	**1365°F**	**1450°F**	**75**	**20-22**	**3-15**	**n/a**	**n/a**
Medium	**1275**	**1360**	70	20-22	3-15	n/a	n/a
Easy	**1240**	**1325**	65	20-22	3-15	n/a	n/a
Ex Easy	**1145**	**1207**	56	14-32	4.5-28	1.5-5	n/a

Silver soldering creates harmful fumes –
ALWAYS turn on the ventilation system
before lighting the torch

Provides information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures.

Product Distributed by Rio Grande
Rio Stk# 101-703
MSDS access on web: www.riogrande.com

Chemtel emergency# 1-800-255-3924

Material Safety Data Sheet

Section 1: Chemical Product Identification

Product Name: Silver Wire Solder Medium
Product Identification: The information in this MSDS is applicable to the products with the following codes: Braze 650 (15-650); Braze 700 (15-700); Braze 750 (15-750)

Section 2: Ingredients and Hazards

Component	CAS No.	Weight %
Silver	7440-22-4	65-75
Copper	7440-50-8	20-22
Zinc	7440-66-6	3-15

Section 3: Physical and Chemical Properties

Physical Form:	Solid
Color:	White to Brass Yellow
Odor:	No Order
Melting Point	1240-1450°F
Solubility in H_2O:	Insoluble

Other commonly-reported physical properties (odor threshold, evaporation rate, vapor pressure, vapor density, oil-water partition coefficient, percent volatiles, percent VOCs, pH, viscosity) are not applicable to these products.

Section 4: Fire and Explosion Hazard Data

Flash point:	Solid Material – Non-Flammable
Flammable Limits:	N/A
Extinguishing Media:	Use dry chemical. Do not use water.
Special Fire-Fighting Procedures:	If fighting a fire in which these products are present, wear a self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.

Section 5: Stability and Reactivity

Stability:
Stable under normal ambient working conditions

Conditions to Avoid:
Silver and copper can form unstable acetylides if in contact with acetylene gas.

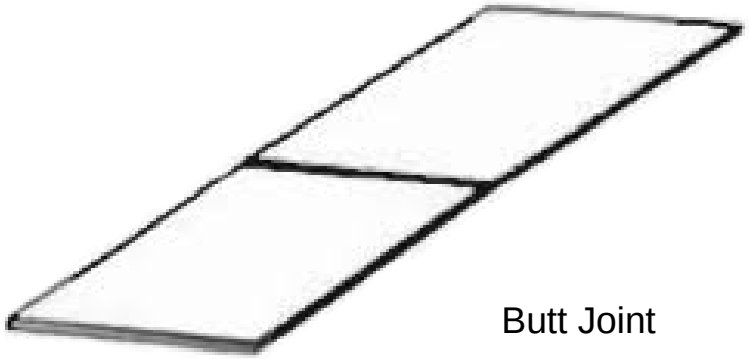
Hazardous Decomposition Products:
Heating to elevated temperatures may liberate metal/metal oxide fumes.

1. A Tight Fit is Imperative
2. All Surfaces Must be Clean and free of oxidation
3. Flux All Parts *and* the Solder
4. Choose the right solder type for the job
5. **Use no more solder than necessary**
6. Heat the entire piece first, then the joint area

Solder leaves a trace of itself anywhere it flows

- To avoid unsightly and difficult-to-remove solder tracks and lumps, use the least amount of solder necessary for the job
- It is better to make your solder pieces smaller and spaced closer together, than to make them larger and farther apart.

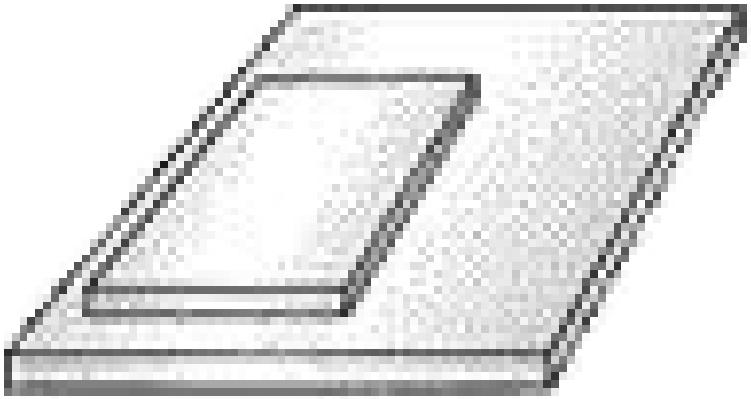
Think about the actual contact area when calculating the amount of solder needed



Butt Joint

A butt joint requires the least amount of solder since the total surface contact area of the two edges being soldered is very small

A sweat joint requires the most solder as it is desirable to have full solder coverage between the two planes/layers being soldered together



Sweat Joint

1. A Tight Fit is Imperative
2. All Surfaces Must be Clean and free of oxidation
3. Flux All Parts *and* the Solder
4. Choose the right solder type for the job
5. Use no more solder than necessary
6. **Heat the entire piece first, then the joint area**

In soldering, it is important that the entire piece to be heated

You cannot *just* focus the flame on the solder joint

Always keep the torch moving – small circles or back and forth motions give a more even heating, and insures that nothing will overheat and accidentally melt!

Heat the largest/heaviest part of your assembly first, before focusing on the joint area

Work quickly, using the appropriate size torch tip and flame size relative to the size of your piece

Allow the solder to flow completely – do not truncate the process

Soldering Objectives:

- Strongest bond necessary
- Neatest seam possible for least amount of clean-up
- Good color match

Remember These Facts About Soldering:

- Solder flows toward the heat source
- Solder likes to flow in cracks and crevices due to capillary action
- Solder likes to flow down due to gravity

Aim to make the above work to your advantage!

Solders come in 4 basic forms: Wire, Sheet, Paste, and Chipped (pre-cut pallions)

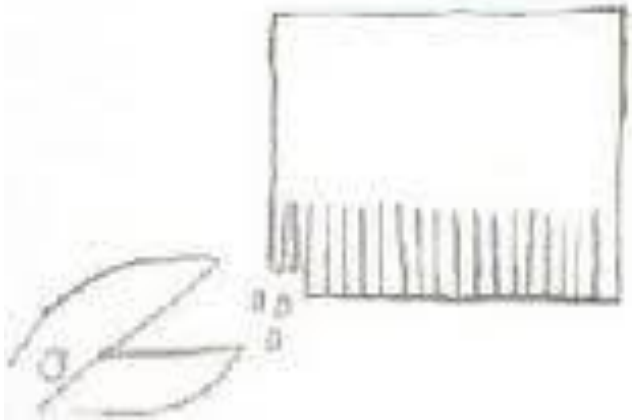
- Wire and sheet solders are most popular

- Paste is often used for repair work or to attach commercial stone settings and findings

- Pre-cut solder is not recommended as it will eventually tarnish and would be difficult to clean

Of all the types, sheet solder is most versatile:

- It can be cut to any size
- It can be made thinner in the rolling mill
- It's easy to cut consistently sized pieces
- It's easy to clean
- Small pieces of solder cut from sheet are called *Pallions.*



Joyce Chen shears cut light gauge metals – they are great for cutting sheet solder. They are easy to find online.

Wire solder is useful where there are long seams that can be easily cleaned up after soldering – this method is called ***stick feeding***. It is difficult to master and requires a steady hand.

- Wire solder can be rolled through the rolling mill or hammered to make it flat

- Wire solder is cut with wire cutters or nippers

- Wire solder fits neatly in the angle of a T-joint seam

Exercise 1: Test Melt

- On a ½” square piece of 22 gauge sheet copper, flux and lay out one each of your 4 solder types (all pallions must be the same size)

- Lay them out left to right, hard to extra-easy and make a mental note of where each grade of solder is

- Place on screen and tripod, then heat evenly from below with a brushy flame that covers the entire square of copper

- Watch as they melt sequentially one by one. Note the time lapse between the different grades

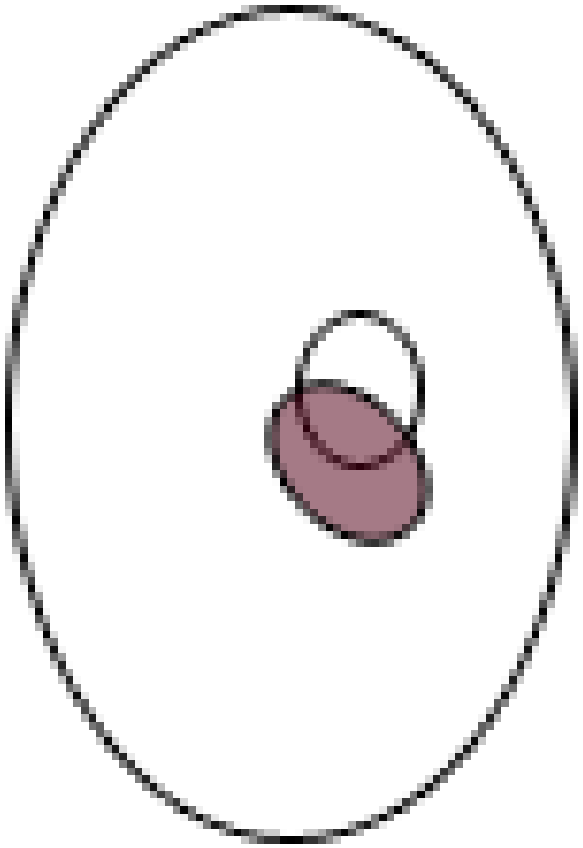
Exercise 2: Play With Your Solder!

- On a ½” square piece of 22 gauge sheet copper, flux and lay out one large pallion of your medium sheet solder

- Place the copper square on a soft fire brick, then heat evenly from above with a brushy flame until the solder reaches its solidus state

- Play with the partly-melted solder by running a titanium solder pick through it; notice its slushy viscosity at this state and then watch as it changes to the liquidus state

Exercise 3: Sweat Joint



•Using 20 or 22 gauge sheet copper or brass, cut out an oval or oval-like shape about 2 inches by 2.5 inches

•Somewhere within the oval shape, pierce out a smaller oval shape; Save the shape that drops out of the cut opening

Make your designs in cardboard first if that helps

part of it sticking over the negative space left from the piercing

•Use white out (Liquid Paper) to prevent solder from traveling into visible areas

•Solder pin findings on the back or pierce a second opening to accommodate a leather cord

End Part One