Working With **Argentium® Silver**

By Cynthia Eid

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Working With **Argentium® Silver**

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Argentium® Silver (AS) is a patented and trademarked alloy that is at least 92.5% pure fine silver (FS), which is the defining characteristic of sterling silver (SS). What makes Argentium different from traditional sterling silver is that a small amount of germanium replaces some of the copper that usually makes up the other 7.5% of sterling silver. Peter Johns, a professor of silversmithing at Middlesex University in England, invented Argentium® Silver in 1996. When I heard about this firescale-free sterling silver sheet, I sought out sources. I finally got my hands on it in the year 2000, from a source in Finland. I hoarded whatever I could get, as I fell in love with the material's working properties. By 2005, I realized that I never used traditional sterling silver in my work anymore, and I sold all my supplies of it.

Rockpot II by Cynthia Eid

Advantages

Blades of Grass by Cynthia Eid

Today, Argentium® Silver is 93.5% silver—even more pure than traditional sterling. The alloy contains about 1.2% germanium, and 5.3% copper. As with any sterling alloy, the copper provides strength to the metal. The presence of the germanium stops firescale as well as providing other advantages.

Argentium® Silver:

- is highly tarnish-resistant (neither pure silver nor any silver alloy is tarnish-proof.)
- has greater ductility and malleability than traditional sterling silver.
- can be precipitation-hardened using a toaster oven.
- fuses, granulates and welds readily.
- does not firescale.

Another of its many advantages is that working with Argentium® Silver is not very different from working with traditional sterling silver. It is useful, though, to know as much as possible about those differences.

Aquatipus by Cynthia Eid

Annealing

Argentium® Silver has annealing and melting temperatures similar to traditional sterling silver.

When we work metal by forging or forming, the molecules can get pushed so tightly together that they cannot move—we feel that the metal has gotten stiff. When we anneal, the spacing between molecules relaxes so that the metal can move. When metal is over-heated, the molecules gather into crystalline clusters that cannot slide around each other as easily as individual molecules, so the metal may develop small surface cracks that can turn into larger cracks—we feel that the metal is "brittle" in this case. For most of us, our intuition is that it is better to get the metal above annealing temperature than to under-heat. And, some say that it is important to quench as quickly as possible after the metal reaches annealing temperature. Unfortunately, both of these actions, over-annealing by getting the metal too hot and quenching the metal too soon, can cause cracking in any metal alloy.

Argentium® Silver glows a paler red when heated to annealing temperature.

In practice, the glow can be hard to see, and it is easy to overheat—especially if we anneal in a lighted room. Another reason that it can be easy to overheat when annealing is that Argentium® Silver heats very quickly since it does not dissipate the heat as quickly as traditional sterling or copper alloys. Rather than watch for a red glow, I find that watching the ink from a black Sharpie® permanent marker to be a good tool when annealing. At annealing temperature, the ink from a Sharpie marker fades to a "ghost," and the silver (if it has been brass-brushed or otherwise abraded) turns whitish. Some people find it helpful to use dabs of flux as a heat indicator—when the flux becomes bubbly, the silver is annealed. Also, watch the color of the flame—when the flame starts to glow a bit orange, the metal is at annealing temperature. Annealed silver looks frosty, not shiny.

Note: Do not cover the surface with flux. Allowing the surface to be exposed to oxygen increases the tarnish resistance of Argentium, as germanium oxide is created. Germanium oxide blocks tarnish and firescale.

Argentium® Silver retains the heat where the torch has been, rather than dissipating and transmitting the heat the way traditional sterling silver and copper alloys do.

It is nearly always best to anneal in sequential areas, rather than trying to heat an entire piece. For instance, when annealing a large piece of metal, or a long piece of thick wire, work one area at a time, then an adjacent area, then the next area, etc. Do not try to get the whole piece of metal hot at one time unless it is a small piece; for example, a 1" (2.5cm) square that is 24 ga. (0.5mm) thick is small enough that it makes sense to anneal the entire piece of metal at once.

It is good practice to use a separate soldering board (my favorite is Solderite™) for Argentium® Silver. This avoids the possibility of the Argentium having its surface contaminated, which can affect tarnish-resistance. I like to use a broad pencil to write on the soldering board, since marker fades with heat.

As with any metal, if you are planning a construction in which you want metal to stay flat, I suggest air-cooling completely with no quenching; this will help avoid warpage. Pre-annealing Argentium® sheet on a flat surface and allowing it to air-cool helps prevent the sheet from distorting during further soldering and fusing operations.

Discoloration: The only way Argentium® Silver discolors when heated is if the metal is positioned so that oxygen cannot reach it and the germanium is unable to oxidize. For instance, there is often discoloration on the side of a sheet of Argentium that was lying against a soldering pad when heated. This discoloration is only on the surface and is fully removable with pickle. After a few more annealings, the surface will be depleted of copper, and the surface will stay white—just as with traditional sterling silver.

Annealing a Coil of Thin Wire

Thin wire can be tricky to anneal since it can be difficult to evenly heat all the wire to annealing temperature. Thin Argentium® Silver wire in a coil can easily fuse together if annealed with a torch. Here are two other methods:

Kiln Method: Set the kiln temperature to the annealing temperature (1112–1202°F/600–650°C). You can take a guess at how long it takes for the metal to reach annealing temperature, or you can watch for the silver to turn white. I like to use a dab of flux to let me know that the metal has reached annealing temperature. When the flux is becomes bubbly, it is at annealing temperature.

Torch Method: A low-tech way to anneal wire without a kiln is to put the wire inside a steel container and heat the container with a torch until the container glows red. I have used the containers that mints and candies often come in, as well as tuna cans (I use a can opener that leaves smooth edges, rather than sharp edges). Before using a container for annealing, I turn on the ventilation and heat the container to glowing red—this a) ensures it is made of a material that can withstand the heat and b) burns off any coatings that may be on the surfaces of the can.

Quenching

Careful cooling is particularly important for Argentium® Silver, because Argentium retains heat longer than traditional sterling, and it can be fragile when it is red-hot.

If you pick up a piece of red-hot Argentium® Silver, you may find yourself with a broken portion of the silver in your tweezers, while the rest of the piece remains on the soldering board.

Though many jewelers and silversmiths quench silver in water immediately after soldering or annealing, my observation, based on my teaching and personal studio experiences, has been that quenching silver alloys too soon leads to warpage or cracking. As a result, I have developed the habit of waiting before quenching. I learned that ALL silver alloys should be quenched at black heat rather than red heat. If we are working in a darkened room, black heat is reached when there is no longer a red glow to the metal. But how do we determine black heat when we are working in a lit environment?

Determining if the metal has cooled to black heat: Here is what I do in order to know when it's safe to move or quench any sterling silver alloy—including Argentium® Silver: I dip tweezers into water and either drip a little water onto the metal or touch the wet tweezers to the hot silver. If the water dances around on the metal in the form of a droplet, or if the water stays on the tweezers, then the metal is too hot to move or quench. If the water sizzles when it touches the silver, then it is cool enough to quench.

This temperature-gauging method is especially important when working with Argentium® Silver. Argentium cools more slowly than traditional sterling because of the germanium it contains. Because germanium is a semiconductor, your work stays hot longer than usual, and may be hotter than you realize when quenched. Simply taking a few moments to clean up the work area is usually enough time for the metal to cool to black heat. Having a way to be sure that the silver jewelry I'm working on is cool enough to quench has been helpful to my students and me.

Cresting by Cynthia Eid

Fusing and Granulation

A Few Thoughts About Fusing...

I believe that there can be more than one "right way" to do something. The right way for you is the way that works for you. For instance, Ronda Coryell is an expert at fusing and granulation, yet I prefer to do some things differently than she does. Likewise, though I hope that the information contained here helps you with fusing and granulating Argentium® Silver, I also recommend Ronda Coryell's DVDs on this topic. And, of course, nothing beats a workshop with one of us!

Advantages of Fusing

- After fusing, the two pieces of metal have become one—you don't have to worry about the joint re-melting during the next fusing.
- Fused joints are wonderfully neat—there is little or no clean-up needed to a fused joint.
- Fusing can be quick and efficient compared to soldering, since the solder does not need to be placed.

Argentium® Silver is wonderfully easy to fuse. My understanding of why Argentium is easier to fuse than fine silver is that, because fine silver is a pure metal, it has a specific temperature point at which it melts and fuses. Alloys (a mix of two or more metals) have ranges of melting temperatures, and Argentium has a very wide range of temperatures at which it melts and fuses. The large temperature range makes Argentium "forgiving" when it comes to fusing, compared to most other silver alloys.

When to Fuse? When to Solder?

Fusing is an option with Argentium® Silver that many people enjoy, but there is certainly no requirement to fuse it. Because fusing actually melts the surface of the metal, while soldering occurs at lower temperatures without melting the surface, fusing is a higher-risk process than soldering. All fusing should be done before soldering, since fusing is done at temperatures higher than the melting temperature of silver solders. I generally fuse early in the process of making a piece. The more time and material I have invested, the more likely I am to choose to solder.

Putting the Torch Heat on the Argentium® Silver

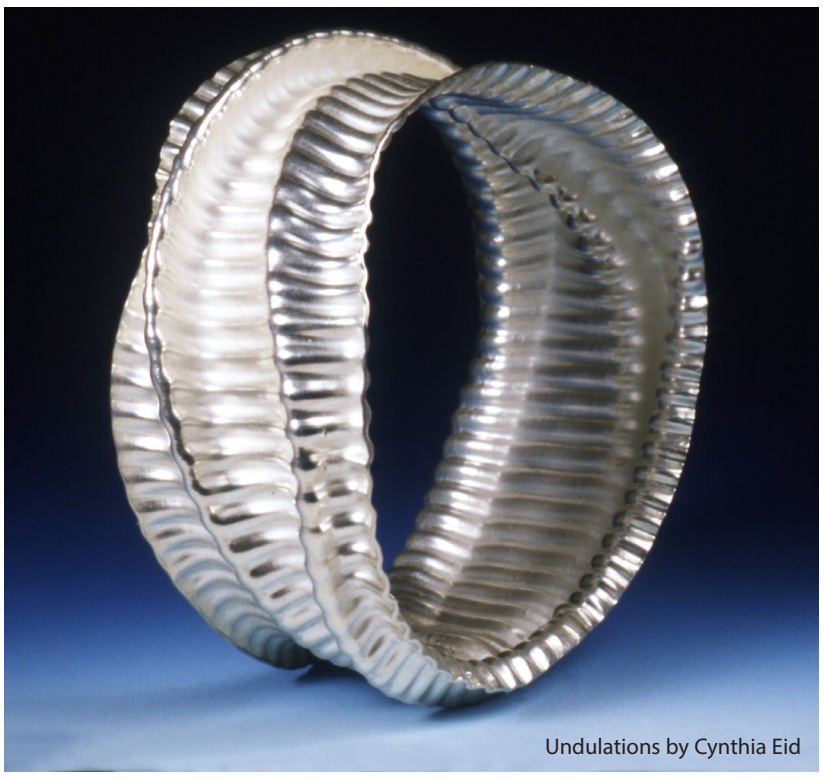
Remember that Argentium® does not conduct heat in the way that traditional sterling alloys and copper alloys do—the heat tends to stay where the torch has been. If you have experience with soldering gold or pewter or steel, you may find that they conduct heat similarly. So, whether I am fusing or soldering, I give the metal a bit of overall heat, and then focus on one area at a time. When that area fuses, I move the torch to an adjacent area. Put more heat on the largest piece of metal, since both the large and small pieces of metal need to reach the same temperature in order to fuse.

The Fusing Process

1) Prepare the joint so that the metal is clean, and meets well. The joint does not need to be perfect, but the better the fit, the easier it is to make a nice, smooth joint that does not show. Metal will not tend to jump across a gap. It is best if the two parts touch.

2) Choose a heat-reflective soldering surface.

- My favorite surface for granulating onto sheet is Solderite™. For fusing wires together, I prefer ceramic blocks for platinum (available at *riogrande.com*) because the surface holds up better under a direct flame. Vermiculite and firebricks work, too. Some people prefer charcoal. Figure out which is your favorite.
- It is ideal to use a block that is used only for Argentium® to eliminate any risk of contaminating the surface, thus preserving the tarnish-resistance.
- Use a smooth surface because textures commonly transfer from the surface onto the hot metal.



Undulations by Cynthia Eid

3) Flux. Though it is possible to fuse metal that is dirty or has no flux applied, these conditions are not ideal for consistent success. The purpose of flux is to keep the metal clean and to help metal flow. Tightly fitted joints also help ensure better results.

- My favorite flux for Argentium® is Rio Grande's My-T-Flux™; Batterns® and Auflux also work well.
- If you are using a Solderite™, ceramic, or vermiculite type of board, you only need to flux the joint; however, I usually flux the entire surface when fusing or granulating since flux is a good temperature indicator of the silver nearing fusing temperature.
- If you are using charcoal, which creates an oxygen-free atmosphere, it is important to flux the entire exposed surface; otherwise, firescale may occur, although, in my experience this does not happen. The reducing atmosphere created by the charcoal prevents any firescale forming on Argentium® in the same way it does using traditional sterling.

Dew Edged by Cynthia Eid

How to apply liquid flux so that the entire surface is covered:

a. Clean the metal to remove all contaminants, including finger oils, scale and oxides, from the surface. (A greasy surface repels liquid and prevents adhesion of the flux.) Heat burns away grease and finger oils; pickle removes scale and oxides. Other ways to clean the surface include scrubbing the metal with a Scotch-Brite™ pad, with pumice and water, or with Penny Brite®. Your metal is clean when water poured onto the surface "sheets off" the surface rather than beading up.

b. Apply the flux with a brush* or sprayer, and then heat the flux gently, using a small, soft flame, to dry it to a white powder. (The flame should be smaller than the flame used for fusing.) If there are bare areas after the flux dries, lightly dab or spray more flux on the bare areas, and gently heat again. Don't let the brush be too wet, or it can liquefy all the dried flux. Ideally, the metal is hot enough that the flux dries immediately upon touching the metal. Brief applications of heat alternating with dabs of flux works best. If the metal discolors, it is an indication that you are overheating it; continue to alternate between applying flux and heat until the metal has a white coating.

*Use natural-bristle brushes, which handle heat better than plastic.

c. Flux the entire exposed surface; there are two reasons for this:

1) The flux is a good indicator of the temperature of the metal.

2) Repeated high temperature fusing gives Argentium® a crusty surface that does not fuse well. Flux on the surface stops this forming and makes fusing easier if you need to fuse on the same surface again.

4) See the joint. Arrange your workpiece and work area so that you can see the joint(s) when the metal fuses.

- I set things up so that the joint is near my eye level. I do this by raising the soldering surface, lowering the chair, or both.
- I wear a magnifier so that I can see the joint well. I have found that it is not always enough to see the surface liquefy. But, if I see the joint (or some of the joints) flow, then I KNOW that there is a strong fused joint.

5) **Heat the areas adjacent to the joint.**

- All the parts to be joined need to reach the same temperature, so put more heat on the larger parts.
- It is important that you not try to "heat the whole thing" when working with Argentium®. After a bit of overall heat, I start at one end and heat areas sequentially. Keep the torch moving in a back and forth or circular movement with the torch over a small area. When the metals fuse in that area, move the torch flame to the adjacent area and heat until that flows, then move to the next area, etc. The first area takes the most time, and then each subsequent area takes less time. If the metal is not a circle or rectangle, start at the smallest area and work toward the larger end of the shape.
- Watch the flux—when the flux separates into tiny droplets, then you know that the metal is almost at fusing temperature.
- When fusing, the surface of the silver melts and looks liquid. Some people say it looks like mercury.
- If the wire or granule melts, but not the surface of the sheet, you need to move the torch more quickly around a larger area of the backing sheet and avoid putting the heat directly on the smaller part to be fused.
- When the metal fuses, the joint looks like it has been soldered—there is a "fillet" of molten metal at the joint. That is what I watch for, whether I am fusing a joint in a ring or a granule to sheet.
- If the metal is still clean, and the flux in good condition, you can bring it back to fusing temperature in order to be sure that you have a good joint. If the joint did not fuse well, it is also perfectly ok to re-do the whole thing after pickling and rinsing well.

6) Let the silver cool a bit. Remember that Argentium® is fragile when red-hot. Let the metal cool a bit before touching or moving it. It is okay to quench at black heat, but quenching while there is still any red glow may result in cracking or breakage. Refer to the "Quenching" section of this paper for a technique to determine when black heat is achieved. As with all metals, I air-cool flat pieces completely on a flat surface because quenching warps flat metal.

- Both quenching and air-cooling are okay. See the previous section on "Quenching" for more details about when it is safe to quench.

7) Check the joint(s). After the metal has cooled a bit, I use tweezers to check whether the granule or joint is truly fused. If the flux and metal are still clean, you can re-heat if the parts did not fuse together; if necessary, pickle, rinse and re-fuse.

8) Quench in water, and test the joints with your fingers. Test granules with a fingernail to ensure they are fully fused.

9) Use hot water to remove flux. This step is optional, but important if you want to have a perfectly smooth surface. If there are thicker areas of flux, they may act as a "resist" and force the pickle to work longer to clear them. This causes a blotchy, uneven surface where the bare metal is exposed to the pickle longer between the thick spots and requires an extra clean-up step using 3M radial bristle discs to smooth the surface.

10) Pickle. Surface discoloration is normal. Pickle and rinse well. Re-fuse if necessary.

Pickling

- Use whatever pickle you are accustomed to. My preference is for sodium bisulfate, which is commonly available as a swimming pool chemical and commercial jewelry pickle. Some people like to use citric acid, or vinegar and salt.

- In my studio, I use one pickle pot for all metals—silver, copper and gold—and have had no trouble (yet!). Blue pickle has a lot of copper in the solution, but still can work very well. As always, it is important to remember to keep iron (tongs, tweezers, and steel wool) out of the pickle pot, as the iron can cause the copper in the pickle solution to plate onto the silver. If you ever do get copper plating on your silver, you can use abrasives or hydrogen peroxide pickle to remove the copper from the surface.

Convergences by Cynthia Eid

Soldering

Just as it is necessary to make a mental adjustment about soldering tactics when switching between traditional sterling silver and gold, platinum, pewter, or steel, it is also necessary to use a different approach when soldering Argentium® Silver.

Solder Vs. Fuse

- Since fusing melts the surface of the Argentium® Silver, and soldering occurs at lower temperatures without melting the surface, fusing is a higher-risk process than soldering. If I'm going to fuse, I tend to fuse early in the process of making a piece. The more time and material I have invested, the more likely I am to choose to solder.
- Is it necessary to fuse? No! If you prefer to solder, and do not feel any urge to try fusing, there is absolutely no need to fuse.

Heat Conductivity

The most important thing to remember with Argentium® Silver is to forget about trying to heat the whole piece of metal at once, or trying to have all the solder flow at once. Argentium Silver does not conduct heat the way traditional sterling alloys and copper alloys do—the heat tends to stay where the torch has been. If you have experience soldering gold, pewter or steel, you may find that they conduct the heat similarly.

After giving the entire piece a general heating, I concentrate the heat on the area of the solder joint, and work my way along the seam as the solder flows.

Night Lumens by Cynthia Eid

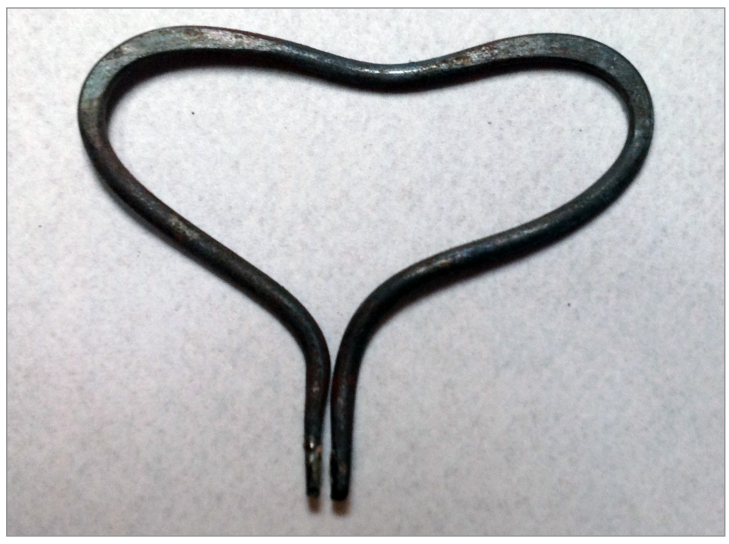
Solders

- Argentium® solders also contain germanium so they are slower to tarnish than traditional silver solders and whiter in color. Their melting temperatures are approximately equivalent to traditional silver solders. There is no harm in using traditional silver solder with Argentium—just be aware that the color-match and tarnish-resistance are not as good.
- Since Argentium® does not transfer heat the way that traditional sterling does, it is usually not as necessary to use a sequence of different solders, since the previous joint is not likely to re-flow unless it is very close to the next joint. I tend to use Argentium medium/hard solder for most joints. For soldering on a post, though, I usually use Argentium easy solder.

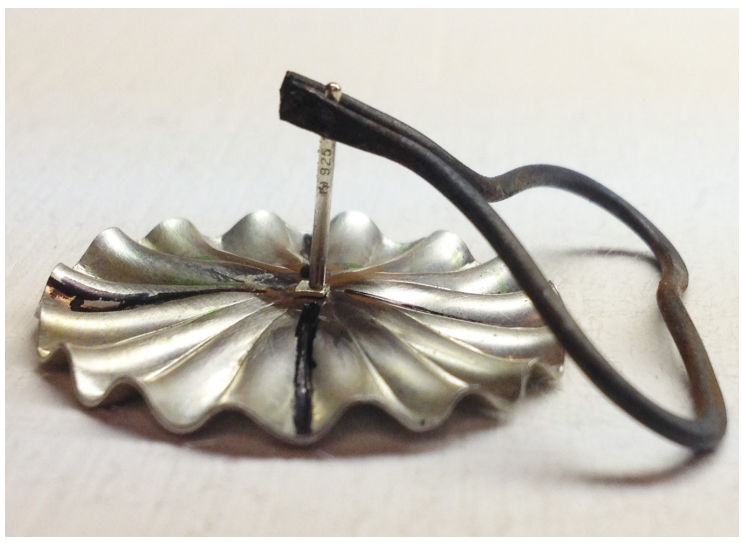
Soldering Boards/Blocks. I recommend that a separate soldering board be used for Argentium® Silver to avoid contamination, which can affect the tarnish resistance. I like to use soldering boards, such as Solderite™ and Rio Grande's ceramic blocks for platinum, that are highly heat reflective. Firebricks and honeycomb blocks are also quite heat reflective, but their rough surface can be regrettable if you overheat. Many people prefer charcoal.

Soldering Flux

- Yellow liquid fluxes, such as Rio Grande's My-T-Flux and Batterns®, and Auflux work best for me. Paste fluxes can cause firescale on both Argentium® and traditional sterling, so I do not recommend them. Gel flux behaves like paste flux, so people who are accustomed to paste flux tend to find gel flux most comfortable to use. Though gel flux can seem rather expensive, a small bottle lasts a long time since only seams need to be fluxed.
- **Flux the seam only when soldering**. It is undesirable to flux all the surfaces, since that prevents formation of germanium oxide. By only fluxing the seam, the germanium oxide will grow thicker, making the Argentium® Silver more tarnish resistant.



A tool, bent and forged out of iron, makes an ideal parts holder during soldering.



Set the post into the holder and position it over the solder.

Binding or Fixturing

- If two pieces do not rest together easily, they can be held together with binding wire or pinned in place before soldering. Do not try to press two parts together during soldering, or to move a piece into better position, as they may break or crack (remember that Argentium® is fragile when red-hot).
- If you use locking tweezers to hold Argentium® pieces in place, such as when soldering a post to an earring, adjust them so that they hold firmly without squeezing too tightly; if the hold is too tight, tweezers can flatten or break the Argentium during soldering. When I taught in the Netherlands, a teacher from Schoonhoven showed me a good way to gently hold a part in place during soldering: He bent and forged a tool out of iron wire to hold the post, then placed the solder under the post. When the solder melts, gravity drops the post into place. I usually use 20 gauge/0.8mm iron wire. For larger pieces, you may wish to use titanium wire or strips. When soldering a post to an earring this way, I aim the torch at the earring, going back and forth in a "U" shape around the post and holding device.

Choices by Cynthia Eid

The Soldering Process

1) **Clean the metal.** I find it helpful to clean both the metal at the joint, and the solder. I like using 3M's Scotch-Brite™ pads, but pumice with water, scrapers, PennyBrite®, and sandpaper also work. Being methodical and thoughtful lead to more consistent success in soldering.

2) **Apply flux.** Use a brush* to apply flux to the seam, then heat the flux gently to dry it to a white powder. If drying does not leave a white coating along the seam, dab more flux on the bare areas and gently heat again. Load the brush sparingly to reapply; if it it is too wet, the flux can liquefy all the dried flux. Ideally, the metal will be hot enough that the flux dries immediately upon touching the metal. Alternating very brief applications of heat with dabs of flux works best. If the metal discolors, that indicates that you are overheating. Continue to alternate between applying flux and heat until the seam has a white coating.

   *Use natural-bristle brushes, which handle heat better than plastic.

3) **Place solder.**

- I put the pallions of solder into a little dish (yogurt lid, pill box, etc.) and flux the solder. The flux protects the surface—if the solder oxidizes, it will requre a higher melting temperature to make it flow.
- I prefer to use a few large pieces of solder rather than many small pieces—less time placing them and fewer places to clean up if clean-up is necessary. At the same time, however, I do not recommend trying to flow solder across very large distances (remember that we don't use the "heat the whole thing" strategy with Argentium® Silver).

4) **Heat the joint with your torch.**

- The objective is to get both pieces of metal to the same temperature because the metal helps melt the solder. Use the condition of the flux on the two sides of the seam as a temperature guide. It may be helpful to put a few dabs of flux a half-inch or so away from the seam as additional temperature indicators.
  –If the solder melts into a ball, that indicates that the heat is being focused too much on the solder and not enough on the metal around it.
  –If one part of the workpiece is larger or thicker, put the torch heat on that part a bit more to ensure it is equally heated.
- After a bit of overall heat, I start at one end and heat along the seam sequentially. Keep the torch moving in a back and forth or circular motion over a small area. When the solder flows in that area, move the torch flame to the adjacent area and heat until that flows, then move to the next area, and so on. The first area takes the most time, and then each subsequent area takes less time. With a 1" diameter bead, I find that the solder flows as fast as I can turn the soldering turntable; larger pieces heat more slowly.

Soldering Notes:

Melt and Flow. Sometimes, solder does not melt completely, even though the solder has flowed along the seam. This is a phenomenon that can happen with any silver solder; the term "skeleton" is used to describe the partially melted pallion of solder. A skeleton usually happens because the heat is being applied tentatively, resulting in the lowest temperature components of the solder flowing before the entire piece of solder flows. If this occurs, do not keep heating in hopes of having the entire piece of solder flow. Clean up the excess solder and heat with a larger flame and/or more boldness next time.

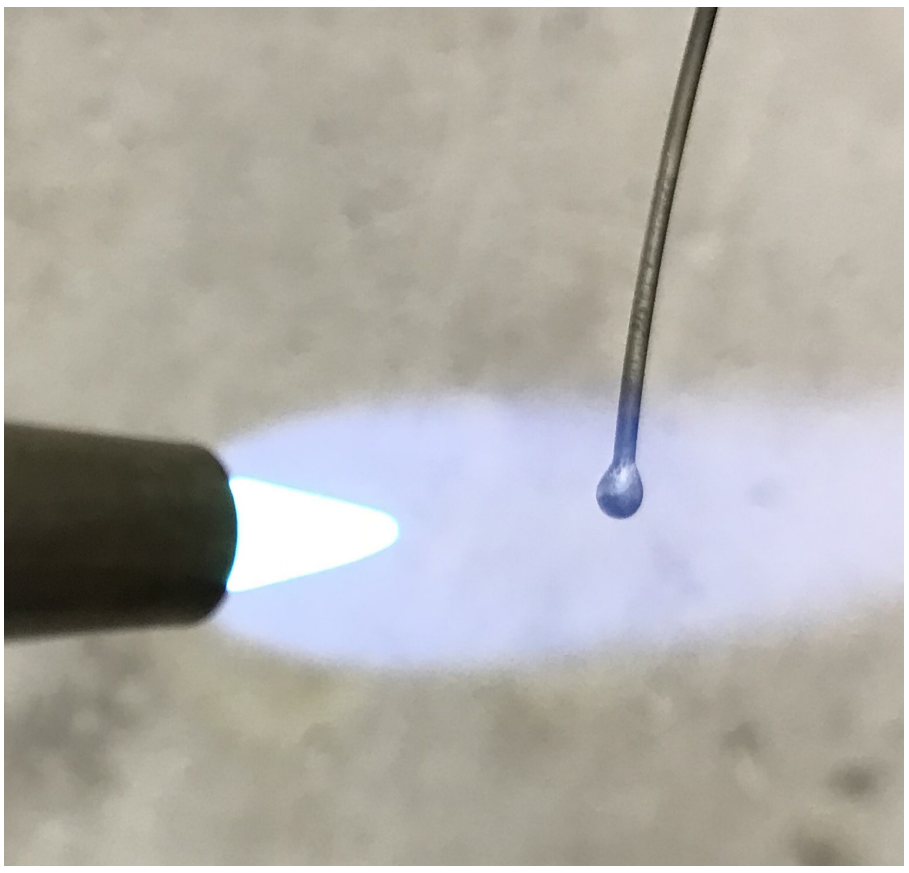
Flat Constructions

- If making soldered constructions of flat sheet, make sure the construction is well supported. If that is not possible, it is helpful to prepare the metal a bit beforehand to help prevent the metal from sagging during soldering. Lay the Argentium® sheet on a flat soldering surface, bring it to annealing temperature with a torch flame, keep it at that temperature for about 15 seconds and then allow it to air-cool.
- Note that the lower the melting temperature of the solder, the less sagging there will be, and that sagging is only a problem with unsupported flat metal. Sagging is not likely to be a problem if 'easy' solder is used. As with any alloy, the thickness of the metal is also a factor in keeping a soldered construction flat. (I have not had any problem with sagging since I generally work with metal that has been formed, but I have investigated the problem for the benefit of those who do work with flat metal.)

Quenching (and NOT quenching). Remember that Argentium® is fragile when red-hot. Let the metal cool a bit before touching or moving it. It is okay to quench at black heat, but quenching while there is still any red glow may result in cracking or breakage. Refer to the "Quenching" section of this paper (page 5) for a technique to determine when black heat is achieved. As with all metals, I air-cool flat pieces completely on a flat surface because quenching warps flat metal. (I often slide flat pieces onto a steel plate to cool.)

Pickle. Pickle and rinse to remove any oxides, just as you would any other metal after silver soldering.

Melting Wire Ends Into A Ball



The technique for melting wire ends into a ball is virtually the same with Argentium® wire.

Most people have no difficulty transferring their technique for melting the end of a wire into a ball from traditional sterling to Argentium® Silver. The ball that is formed on Argentium wire is generally smoother than the ball formed on traditional sterling wire. Here are a few tips you can try if you have difficulties:

- Clean the wire to remove any oil left from drawing down. I like to use Scotch-Brite™ pads. Don't use steel wool, which contains oil to prevent the wool from rusting.
- Use as small and hot a flame as possible, as quickly as possible, so that the heat does not have time to travel up the wire.
- For large wire and/or creating large balls, try holding the torch flame just below the end of the wire to minimize any possible thinning effect on the wire next to the ball.
- Although flux is not always necessary, it can be helpful.

Finishing, Hardening and Tarnish-Resistance

File, sand, and polish completely, using the usual processes and methods that you are accustomed to. Take the silver to a rouge finish, if that is your preference. Some good satin finishes can be achieved using a brass brush or bronze* wool with soapy water, with Scotch-Brite™, or with radial bristle discs.

*I prefer bronze wool rather than steel wool because steel wool can cause rust and contaminate pickle.

- If you like a tumbled finish, I find that a good tumbling solution, such as Super Sunsheen™, works better than dishwashing liquid.
- To protect the tarnish-resistance properties of Argentium®:
  –Keep separate finishing tools for Argentium®; tools used on other metals could smear the prior metal onto the surface of the Argentium, disrupting its tarnish-resistance. In my studio, that means that I keep separate buffs for Argentium.
  –Remove all traces of grease after polishing; greases are organic substances that break down with time and discolor the silver. Metal is grease free when water "sheets" off after cleaning, rather than beading up on the greasy surface.
  –Consider using one of the new water-soluble polishing compounds, which may be easier to remove, and less greasy.
  –If you use an ultrasonic cleaner, use a good commercial solution such as Sparklean™, rather than soap and ammonia.
- Tips for finishing fused work:
  –Cup burs can round off a granule that is not as spherical as desired.
  –Radial bristle discs are excellent for smoothing around fused wires or granules, and for acheiving an even finish.
  –If you plan a polished finish, use radial bristle discs after each fusing and pickling step to keep the metal smooth.

Heat To Increase Tarnish-Resistance. Neither pure silver nor any silver alloy is tarnish-proof. With heat, however, we can maximize the tarnish-resistance properties of Argentium® Silver. At temperatures over freezing, the germanium atoms get excited and grab oxygen, creating a layer of germanium oxide on the surface of the metal. Germanium oxide (GeOx) is invisible to the naked eye; it prevents oxygen from passing through silver, thus largely preventing tarnish and firescale.

Hardening is not a requirement for Argentium®, but it is an option that makes the metal sturdier while increasing the tarnish-resistance at the same time. Clean the Argentium and avoid touching it with bare fingers before hardening. Hardening works on air-cooled silver or partially work-hardened Argentium. Though in my own work I don't need maximum hardness, you can achieve maximum hardening when the Argentium is annealed, quenched at black heat (refer to the "Quenching" section of this paper), and then hardened.

- **Temperatures** (kitchen oven, toaster oven, or kiln can be used):
  –Fastest: 572°F/300°C for 2 hours. Remove from oven/kiln. Air cool.
  –Easy (if you have a kiln and time): 572°F/300°C for 1 hour. Turn the kiln off and allow the kiln with the work inside to cool to room temperature (overnight works well).
  –Lowest temp: 350°F/175°C for 3–5 hours. Remove from oven/toaster oven. Air cool.
  –'In-between' temp: 450°F/230°C for 2–3 hours (my usual method). Remove from oven. Air cool.
- **Time:** Though the times are approximate, do not heat over-long when hardening—not more than 4 hours.
- **TIPS:**
  –Do not enclose the Argentium® Silver when heat-hardening; exposure to oxygen is needed to create the germanium oxide that prevents tarnish. In an oven, I usually use a glass baking dish; in a kiln, I use a clean soldering board. I think that a stainless pan would be ok, but I avoid aluminum, since it has potential for contaminating silver.
  –Though an oven does not need to be spotless, it should be fairly clean. If there are food drippings on the bottom of the oven, the smoke resulting from the burning food may discolor the metal.
  –Using a kitchen oven in which food is also cooked has no known harmful effects; nevertheless, it may be prudent to use a separate toaster oven or kiln for hardening.
  –Pickle after hardening to remove discoloration (and copper) from the surface.
  –Re-brighten the surface if necessary, by lightly repeating the final finishing step (lightly rouge, or use an Argentium® Silver Care Cloth, or re-tumble briefly, or brass brush with soapy water).
- Other metals: The hardening process will not have any harmful effect on fine silver, sterling silver, gold or copper alloys that are used in combination with Argentium® Silver. Any discoloration is removed with pickle.
- Re-do: Should the need arise, the alloy can be annealed and then re-hardened.

You Can Use Lower Temperatures for Anti-Tarnish. If stones have been set before heat hardening, or if you abrade through the finish created by hardening, use any heat that is safe for the stones to encourage the formation of GeOx. I sometimes heat for two hours at 210°F/100°C to re-generate GeOx. The most durable GeOx is created at 210°F/100°C for 16 hours, but even 100°F for an hour is helpful. This temperature does not usually cause discoloration.

Add Thiol to the metal surface for additional tarnish-resistance. Thiol is an ingredient in Argentium® Silver Care Cloth, Silver Glory (dip), Goddards™ Long Shine Silver Cloth and polishes, and Tiffany mitts. This chemical seems to bond with Argentium to help further prevent tarnish.

Patinas. Any chemical normally used to darken silver will work on Argentium® Silver; the process may take longer than traditional sterling, or need a slightly stronger solution. Use your normal procedures.

SNAG Lifetime Achievement Award by Cynthia Eid

Setting Stones

- If the stones in question are synthetic or diamonds, you can generally set them and finish completely before heating to harden and/or maximize tarnish resistance. (See "Which stones are heat-tolerant?" below.)
- For other stones, you can choose to harden your metal before setting your stones. Prongs and bezels are not brittle from hardening; they are stiffer than annealed Argentium® but softer than 14KYG. Fine silver and 22K gold bezels are still soft after the hardening process.
- Remember that hardening is an option, not a requirement. You can choose to skip hardening, and simply heat gently after all the finishing, to increase tarnish resistance. The optimal temperature for this is 210°F/100°C for at least two hours, but any heat is helpful.
- If the stone is very heat sensitive, use a thiol-containing cloth or liquid to increase tarnish-resistance and protect the surface. Over time, germanium oxide will form underneath the thiol, adding further tarnish-resistance.
- **Which stones are heat-tolerant?** Here are a few sources with information about stones and heat-tolerance:

  http://www.studleysjewellers.co.uk/gemstone-guide/

  https://www.cooltools.us/v/vspfiles/assets/images/Article-Gemstones_In_Metal_Clay.pdf

  https://www.gia.edu/gems-gemology/summer-1987-gemstone-durability-martin

Folded Earrings by Cynthia Eid

Working Procedures/Sequence

Depending on what finish you like and how you usually work, a few small adjustments in your procedures may be necessary in order to work efficiently and achieve hardness and tarnish resistance. To help with planning, here are several *possible* work sequences:

For a Scotch-Brite™ or satin finish:

- Saw, form, and drill.
- Solder on the finding.
- Pickle and rinse.
- Scotch-Brite™, radial bristle disc, or sand.
- Harden (simultaneously increasing the germanium oxide protective layer on the surface).
- Pickle and rinse.
- Patina if desired.
- Re-brighten metal by brass brushing with soapy water or lightly re-do a satin finish.
- Use a thiol-containing cloth or dip for added tarnish resistance — Argentium® Silver Care Cloth, Silver Glory, or Goddard's Long Shine Cloth.

For a polished piece:

- Saw and form the metal.
- Solder and pickle.
- Polish (this removes the germanium oxide).
- Harden in the oven (simultaneously increasing the protective germanium oxide layer on the surface).
- Pickle and rinse.
- Patina if desired.
- Rebrighten by polishing lightly.
- Use a thiol-containing cloth or dip for added tarnish resistance — Argentium® Silver Care Cloth, Silver Glory, or Goddard's Long Shine Cloth.

For a piece with a stone:

- Saw, drill and/or form the metal.
- Solder and pickle.
- Finish—polish or satin finish.
- Harden in an oven or kiln.
- Pickle and rinse.
- Patina if desired, and/or re-brighten the silver by lightly repeating the final finishing step (e.g. rouge or brass brush with soapy water).
- Set the stone.
- Use a thiol-containing cloth or dip for added tarnish resistance — Argentium® Silver Care Cloth, Silver Glory, or Goddard's Long Shine Cloth.

Ultrasonic Cleaning

Ultrasonic cleaning solutions should be pH-neutral (pH6–pH8) for any sterling silver, whether traditional or Argentium®, since high-alkaline liquids attack all sterling alloys. The metal can look etched or discolored, especially if the ultrasonic is run very hot (above 120°F/49°C). Peter Johns learned the hard way that solutions labeled as neutral are not necessarily so. Use your own pH test strips to check the pH; disposable paper strips are available at pharmacies and aquarium/pet stores, as well as on the web. I have also been told that an ultrasonic, if run with too much force, can attack the surface of any metal. A good practice is to soak a piece in the ultrasonic solution for a few minutes before turning the machine on. This loosens the polishing compound or dirt so that the metal needs less time exposed to the ultrasound.

Reticulation

A few people have successfully reticulated Argentium® Silver, but a reliable protocol has not been established yet.

Enameling

Argentium® can be enameled. Opaque enamels work just fine. The best success with transparents on AS 935 has been with torch enameling. Kiln enameling on AS 935 tends to turn transparents gray with multiple firings. One way to take advantage of the special properties of Argentium is to fuse elements that would have been soldered with other alloys, then put an opaque enamel down, and use transparents over the opaque, or over foils. AS 960 works well for transparents but, in the U.S., sheet and wire are not available in 960.

Keum Boo

For keum-boo, I use the same techniques with Argentium® Silver that I use for fine silver or traditional sterling with the exception of surface preparation. I find that it is usually adequate to heat and pickle the Argentium® one time before applying gold foil. Though the surface may turn black during application, the bond seems to be fine.

Casting

I don't do my own casting, so I recommend the technical information documents (pdfs) available at: https://www.argentiumsilver.com/user-guides-downloads.

Note that casting grain is available in "935 Pro" and "960 Pro"; sheet and wire are referred to as "millforms."

Safety

If you are like me, you may wonder about the safety of germanium. I know that when I first heard about this sterling alloy, I was quite concerned about its safety. I looked on the web at the MSDS for germanium, as well as those for silver and copper. Since the lists of dangers for silver and copper are longer than the list for germanium, I feel that it is a safe component for sterling silver. Both silver and germanium have anti-bacterial qualities that are used in the medical field.

Naturally, one should always use safe work habits when working with any metal. Wear a dust mask and safety glasses for grinding or polishing. Use good ventilation for soldering, grinding and polishing. Don't eat or drink in the studio. Use common sense and take precautions to protect your health and safety.

It is interesting to note that using Argentium® Silver could make many workplaces safer, since cyanide and/or nitric acids would no longer be needed to deal with the firescale common to traditional sterling silver.

FAQs


Gyrations by Cynthia Eid

Traditional sterling or Argentium®? How can I tell?

Here is how I test a piece of metal to find out if it truly is Argentium® Silver: first, abrade the surface using sanding paper, Scotch-Brite™, or other abrasive to make sure there isn't a fine-silver or germanium oxide surface coating. Then heat the metal with a SMALL torch flame, being sure to take the flame off the metal frequently to let oxygen get at it. If the metal is Argentium®, it may turn black but, as you keep heating, the germanium and germanium oxide do their thing, and the metal will turn whitish again. If the metal is traditional sterling, it will turn black and stay black. It can be helpful to test a known piece of each alloy at the same time to compare results.

Fine Silver? Or Argentium® Silver?

Clean and heat the metal, as described above. Fine silver does not discolor when annealed or melted.

How do I quality-mark Argentium® (in the U.S.)?

- When marking a piece made with Argentium® Silver in the U.S., the only legal requirement is to stamp it as "925" or "sterling silver," since Argentium® is sterling silver.
- Many people choose to mark it "935"; 935 stamps are available from Rio Grande. If you hand-engrave your marks, you might choose to mark your work "A935" or "Argentium® Silver."
- If you want to use a flying unicorn, which is the logo for Argentium®, you need to register with Argentium International. There is no charge for registering. Here is the link to the trademark registration page on the Argentium Silver web site: https://www.argentiumsilver.com/brand-and-tm-licence-registration.
  Registration is required because Argentium International has to show they are protecting their brand. If they do not do this, they risk losing control of the brand at some future time.
- Large manufacturers may wish to contact Argentium® International Ltd. about their partner program for access to the artwork for the logo for laser marking, co-advertising, etc.

How do I handle Argentium® scrap?

You don't need to separate Argentium® scrap from traditional sterling scrap. It is all sterling. If anything, the presence of germanium will improve the alloy.

I've fallen in love with Argentium® Silver! What do I do with all the traditional sterling that I already have?

Option A: Combine it with Argentium® Silver to use up the traditional sterling. Many people simply solder them together. There will be differences in tarnish resistance, and it could be a little tricky to deal with, given the different heat-conducting properties, but many people have told me they have no problem combining the two alloys.

Option B: Sell your traditional sterling to someone who does not like Argentium® at a price that is between scrap value and retail. This can make both parties to the deal happy.


Sea-ish XIII by Cynthia Eid

Germanium and Argentium® Silver

What is germanium?

Germanium (Ge) is an element named for its discovery in Germany in 1886. It is chemically similar to tin and silicon. It is a metalloid, meaning that the element has both metallic and non-metallic properties. Metalloids tend to be semiconductors rather than conductors. Germanium is a semiconductor with electrical properties between those of a metal and an insulator. Because germanium is less conductive than many other metals, Argentium® Silver is easier to fuse and weld.

Pure germanium is crystalline, gray in color, and has a lustrous appearance. It is very brittle and shatters easily with a hammer. Interestingly, it seems to have a bleaching characteristic when alloyed— the alloys made with it look more white and less yellow.

Pure germanium in its natural state.

How did germanium come to be alloyed with silver?

A company named Metaleurop, whose primary product was zinc, found that they had a lot of germanium as a by-product of refining zinc ore. In hopes of finding a market for germanium, Metaleurop sent samples and inquiries to people in many different areas of expertise; one of these people was Peter Johns at Middlesex University in the United Kingdom.

The germanium that Metaleurop gave Professor Johns to experiment with was mixed with copper. When he melted this alloy, he noticed how cleanly and easily it melted and cast—which is unlike pure copper. From this observation, Peter Johns realized that the germanium was protecting the copper from oxidation.

Chameleon Dinner for Two by Cynthia Eid

Firescale—what it is, and why it occurs

Silver is one of the few metals that allow oxygen to penetrate the surface. During annealing or soldering, oxygen attaches to the copper under the surface of traditional sterling silver, creating cuprous oxide (Cu_2O)—known to us all as firescale or firestain. This dark layer forms under the surface of traditional sterling silver and does not come off in pickle. Firescale can be removed by polishing, strong acid, or electro-stripping. Firescale can be covered up by plating or by depleting the copper from the surface through repeated cycles of heating and pickling (called "depletion gilding" or "bringing up the fine silver").
Note: The oxide that occurs on the surface of both traditional sterling and Argentium® silver after heating and that is removed by pickling is cupric oxide (CuO).

How does germanium prevent firescale?

Germanium is an "oxygen grabber," meaning that it is more aggressive about grabbing oxygen than copper. The germanium combines with oxygen to produce germanium oxide, which is invisible to the naked eye, and forms a barrier at the metal surface. Since oxygen cannot get inside the Argentium®, Cu_2O (firescale) cannot form. Argentium may discolor from soldering or annealing, but the discoloration is only on the surface, and it comes off in pickle.

Why does Argentium® Silver harden so well?

Argentium® Silver hardens well because germanium is a metalloid rather than a true metal; germanium atoms tend to "float" around within the silver/copper alloy relatively unimpeded. When Argentium® Silver is heated, the germanium precipitates out of the alloy and forms its own crystal structure. Because the germanium crystal structure has a different geometry than the silver/copper crystal structure, the two structures interlock, thus making the metal harder.

What else is germanium used for?

- Fiber-optic cable—this application is the largest use for germanium.
- Infrared night-vision goggles. Night vision systems are the second biggest use for Germanium.
- As a polymerization catalyst in the making of plastic water bottles. This is the third largest use. It is considered safer than the alternative, antimony trioxide.
- Landell Flutes and other flute-makers are now making flutes of Argentium® Silver. They feel that their projection and tone are better because of the increased hardness, which is similar to an old age-hardened sterling flute.
- As a phosphor in fluorescent lamps.
- As a transistor element; germanium transistors are still used in stomp-boxes by musicians who wish to reproduce the distinctive character of fuzzboxes from the early Rock & Roll era.

Oxides vs. Tarnish

- Tarnish is not truly an oxide; it is silver and copper sulfide. Tarnish occurs when silver is exposed to sulfur-containing compounds. The sulfur may be in the air, or it may be in a chemical that is applied to the silver. There can be many contributing factors that can cause an alloy to tarnish: environmental conditions, perfume, deodorant, chemicals used in manufacture, solder temperature, packaging, skin conditions, water, sulfur or chlorine, and more.
- Metalsmiths typically think of an oxide as being black, but this is not always true. Glass, for instance, is silicon oxide—it's transparent.
- We rarely see silver oxide. It is a light to medium gray color—it is that pale gray color we see if we use nitric acid to etch or strip sterling silver.
- Germanium oxide is somewhat transparent and whitish.
- Sterling silver forms several oxides, including cuprous oxide (Cu_2O) and cupric oxide (CuO). Cuprous oxide, commonly called firescale or firestain, forms within traditional sterling silver. Cupric oxide (CuO) is the dark surface film that is easily removed by pickle.
- Silver (the element) is unusual in that it lets oxygen pass beneath its surface. That is why other metals have a surface oxide only, not the underlying firescale problem that traditional sterling silver has.

Learn More

- Argentium® International Ltd. offers technical information, as well as information about the company are available at www.argentiumsilver.co; technical assistance is available via e-mail at info@argentiumsilver.com.
- Rio Grande®, a distributor of Argentium®, has an experienced technical staff available via phone or email.
- Join the Facebook group Argentium Silver Network Page to learn more and to ask questions.
- Purchase and watch Ronda Coryell's DVDs. Clips are available on YouTube.com
- Purchase and watch Cynthia Eid's videos from www.interweave.com or https://www.craftdaily.com.
- Take a workshop from Cynthia Eid or Ronda Coryell.
- I would love to hear about any innovations or discoveries made about Argentium® Silver and/or its use! Contact me by email at cynthiaeidmetalsmith@gmail.com: see my work at www.cynthiaeid.com.