PRESSED SOFT METAL MOLDS: A FORGOTTEN TECHNIQUE

John Berg
Retired VP of Manufacturing Excellence
David Yurman, Enterprises
New York, NY USA

Owner of Hair of the Dog Ceramics LLC
Mahopac, NY USA

INTRODUCTION

I have been making jewelry for 50 years and one of the most memorable techniques that I have learned over the years has been pressed soft metal molds. It seems to have become an almost forgotten technique in the jewelry industry. I learned it about 30 years ago back in the mid 1990's. I do not use it often, but I have used it for several projects for different companies since. The types of projects have been emblematic jewelry, pendants, lapel pins, cufflinks, rings and large bracelet cuffs.

The goal of this paper is to re-introduce pressed soft metal molds to the industry and offer a less expensive solution to rigid metal molds. There are many types of these rigid molds or, as they are usually called, metal molds. They may be CNC machined, pantograph, or produced by EDM machining. Most molds are made for reproducing two dimensional items. Any form of undercut requires molds with inserts which will add considerably to the complexity and the cost of a mold. Very early in the history of lost wax casting a technique was perfected which resulted in very precise molds, often multiple piece molds, capable of producing wax patterns without shrinkage and with excellent detail. With the advent of the Second World War most flexible molding materials disappeared and for the duration soft metal molds were in extensive use.

Today except for a few specialized applications they have well disappeared from the scene but I think the techniques are viable and deserve to be preserved so that future generations of jewelers have the knowledge and ability to use them. The information will present techniques that could be executed in-house by skilled bench jewelers using common low-tech tools and equipment to larger manufacturing shops that have access to machining equipment and advanced technology. I know of a handful of manufactures that still use the technique, in the USA, Costa Rica, China and India. They all have their own methods and types of projects that they use it on. The basic method is similar, the types of models vary, and some incorporate CNC machining. Some use a similar model that is used for conventional rubber molds. These in my experience are used for larger pieces like cuff bracelets and the wall thicknesses can be maintained with these rigid molds opposed to rubber molds that tend to expand with the needed pressure to fill a large cavity. This can result in thicker wall thicknesses that exceed the desired specifications. This method is limited to about a minimum wall thickness of 0.50 mm as that can be the limits of casting a model with a consistent wall. Another method, which I like to use is to make the models solid and once the outside of the mold is pressed to your liking a core of soft metal is poured into the mold. This will make a core that completely shuts off the mold. That core is then removed and a series of "witness marks" are ground into the surface of the core. I have been able to achieve wall thickness as low as 0.30 mm thick with this method. I will cover more of this technique later in the paper.

There are other methods for making flat pieces like pendants, lapel pins, cufflinks and coins. The main issue with these types of pieces is if they are two sided. If they are one sided these are quite easy as the back side of the mold can be flat stock aluminum. If the piece is double sided, it can be a challenge to suspend the model so that it sits flat and parallel to both halves of the mold frame so a proper seam line can be established. Albert M. Schaler wrote a paper for the Santa Fe Symposium in 1998 and he presents a method of using dental stone as a backing to press the parts against. I have not used this technique so I cannot speak to its advantages or disadvantages. I will be presenting the method that I am familiar with but there are many different approaches that should be considered and investigated to see what method may be best suited for various purposes.

List of materials needed:

- Aluminum mold frames (machined or sand casted)
- Steel or brass cylinder plugs (for rings) different diameters for various ring sizes
- Brass "V" plugs, sizes to match the cylinder plugs.
- Soft metal for pressing around the model (Bismuth and Tin alloy) The key to soft metal molds is a variety of bismuth-based alloys. Bismuth is a heavy, coarse crystalline metal which expands as it solidifies. This characteristic it shares with antimony and water but bismuth expands even more than water,

3.3% by volume. The alloying metals used may be lead, tin, cadmium, or indium. I like to stay away from the alloys containing lead. Alloys containing more than 50% of bismuth will tend to expand during solidification; alloys containing less will tend to shrink. Depending on the alloying materials we find melting points ranging from about 115° to a little under 500° F. Several alloys are eutectic, i.e. they have no freezing range between liquidus and solidus. Other alloys do exhibit definite freezing ranges. These materials were first developed and marketed beginning around 1930 by Cerro de Pasco under the trade names of Cerrobend, Cerrosafe, Caerromatrix, Cerrocast. The names referring to primary uses and also to the melting point of the various alloys. Today there are several manufacturers of these alloys. They are widely used in industry for making a variety of holding fixtures, as bearing materials, as fillers for tube bending, and so on. Most alloys will show no shrinkage after they are cast, a few will even grow minutely at the rate of a few ten thousandth of an inch. While this helps to ensure perfect adhesion in many applications it is of lesser importance in the making of pressed molds where we rely on a final application of pressure to insure perfect reproduction of a surface. I use an alloy that melts at 281° F. I know of 2 companies that supply this "Tru Alloy". Hi Tech Alloys, hitechalloys@oz.net Belmont Metals https://www.belmontmetals.com/product/tru-alloy-281f-138c-low-melting-alloy/

- A method of melting the soft metal. A ladle and a hot plate or flame. I prefer an electric melting pot.
- Nail polish or similar type of masking lacquer
- Powder as a release agent. (corn starch or mica could be a safer alternative to talc powder)
- Plasticine clay for blocking of sections of the mold and establishing parting seams.

List of tools to use:
- Flex shaft or micro motor with assorted burrs
- Files assorted shapes and coarseness. 0 to 00 cut files work well.
- Small spatulas made of wood, plastic, or copper for working with plasticine clay. Use a softer tool to prevent scratching the surface of the bismuth alloy as it can be easily damaged with steel stools

Mold frames
Several different types and styles of mold frames can be used. It is recommended to use aluminum because it's relatively easy to

produce and work with, it doesn't rust or retain heat (making it too hot to handle). The size and the shape of the mold frame can vary, however, once a style is adopted, you'll probably want to stay with that type of mold frame. I've seen round, 4-sided, and 6-sided frames. Personal preference and availability will influence your design choice. I have used 4-sided frames but have seen round and 6-sided frames used at different companies. I prefer the 4-sided as they are easily squared off with parallel sides that fit nicely into the plastic injectors that have vertical injecting nozzles. This helps keep the nozzle square to the mold and establishes a tight fit so that the plastic fills the mold properly. I've only seen round frames used with wax injectors as they can be hand-held or clamped like rubber mold injection. The most important aspect should be that the two faces of the mold should be parallel.

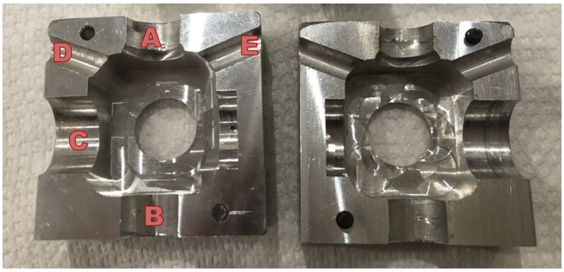


Figure 1: 4-sided aluminum mold frame

Figure 2: 6-sided aluminum mold frame

Figure 3: Round aluminum mold frame

BERG

With reference to the inside of the mold in the 4-sided photo, areas marked A.B.C.D.E. are all half round channels, that form round openings from the outside of the mold to the inside ring cavity, when the two mold halves are placed together. All these channels must be in the center of the parting line of the two mold frame halves. The only one of these channels that needs to be machined accurately is channel is the (C) channel that the ring plug will fit into. This channel must be machined to the desired ring size after the two halves are pinned together. The channels for the top (A) and bottom of the mold (B) can have an opening of approximately 3/8" diameter, these openings can be cast or machined, accuracy is not important. Channel (D) and (E) are for the top sides of the ring. These are not always necessary to use, and should only be used when the ring style dictates their use. Channels (A), (C), (D) and (E) are all for removable parts. It is a good idea to put a slight depression using a flex shaft with a round bur, in channels (A), (D) and (E), just on one side of the mold halves. This will aid in putting the mold pieces back together when using the mold in production. I have purchased machined aluminum mold frames from A.B. Machinery in Montreal, Canada. They seem to be low on stock and may not be producing them now. I had Bob Aletto from Boca Raton, Florida machine the 4-sided flat mold for me recently. The 6-sided and round mold frames pictured above are examples of sand casted mold frames.

Vulcanizing press

A rubber mold vulcanizing press works well. The vulcanizer must have temperature control and must heat from top and bottom. I recommend setting one vulcanizer for metal molds (temperature setting is different than for making rubber molds) and leaving it exclusively for metal molds. Temperature control is very important and once you arrive at the perfect temperature setting you will probably prefer to leave it set there. A cooking thermometer works well for regulating the vulcanizer temperature. Before putting a mold in the vulcanizing press, the temperature should be held constant for at least 15 minutes. I have seen heated hydraulic presses used as well which can be an upgrade from a jewelers screw press vulcanizer.

Plastic injector or standard jewelers wax injector

Plastic injectors can cost a few thousand dollars depending on the model. I have used plastic injectors from A.B. Machinery in Montreal Canada. Used injectors can be found on line from $300 to a couple thousand dollars. Try to find one that is designed to work with 2" x 2" to 2.5" molds for most standard ring and pendant molds. Air pressure wax injecting pots can work well for many molds and most jewelers have one of these older type of injectors that go up to 15 to 20 lbs. of pressure.

Plasticine

Any children's non-hardening plasticine clay, available from your local hobby or arts supply store, will work well. Other materials could be used, but plasticine seems to be the easiest to work with.

"C" clamp

Available from any hardware store, a regular c-clamp, with an opening of approximately 4-inches, will be needed. Try to find clamps with a flat smooth end on the screw part. Some versions have a depression in them that will not put the direct pressure where it is needed.

Source for melting the soft metal alloy

I have seen different ways to melt the bismuth alloy. A torch or Bunsen burner can be used to melt the alloy in a ladle. Care must be used with this method not to over heat the metal. As soon as the metal has become liquidous it is time to pour your mold. An electric burner can be used as a heat source to melt the alloy in a ladle as well. I prefer to use an electric hot pot (similar to what is shown in Figure 4 that can be purchased at most jewelry supply companies.

Figure 4: electric melt pot

Process for making a ring mold

Fit ring model (pattern) on to solid plug. A tight fit is essential. Dust the ring model with a powder at this point (mica or cornstarch are good substitutes for talc).

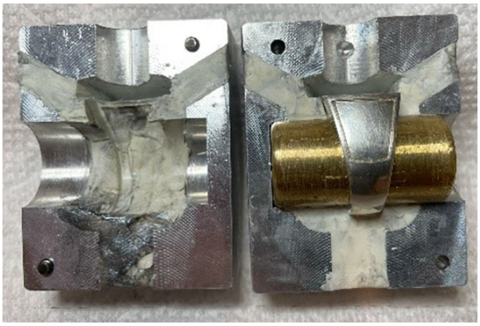


Figure 5: preparing top section to be poured

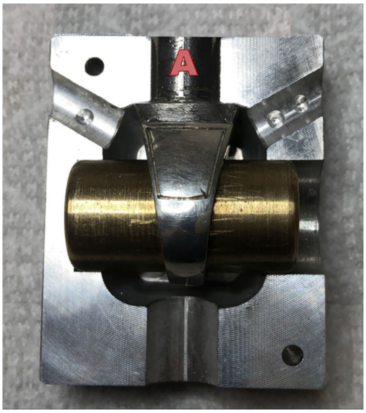


Figure 6: Channel A for pouring top section

The ring top section will be the first piece made. Plasticine clay should be used inside of mold cavity to stop molten metal from going into unwanted areas. It is always better to leave an oversize cavity around the top of the ring, than to try to be exact with carving away plasticine.

When both mold halves are placed together with the ring model on the steel plug inside, you should be able to look into mold through channel (A) and see top of ring centered below mold opening. All channels should be effectively blocked with plasticine, except the top opening, to stop and contain all molten metal. (channels (B), (D) and (E) should be filled with plasticine completely).

Clamp the 2 mold halves together with a c-clamp or rubber bands. You're now ready to pour the first piece. Heat soft metal in a ladle until molten. Do not overheat. I like to use an electric melting pot to melt the metal. A thermometer can be submerged into the molten metal to monitor the temperature and keep it as low as possible in it's liquidus state. Pour melted metal the into mold, through the top opening (channel A). Pour enough extra metal to form a button on the outside of the mold, this extra metal supplies enough metal during the pressing part of the process.

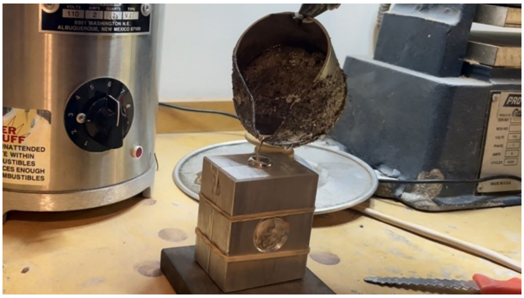


Figure 7: pouring top section of ring mold

Soft metal will solidify very rapidly (assuming it was not too hot when poured). Remove the rubber bands and open mold. The two aluminum halves should be separate with soft-metal probably stuck to ring model and solid plug. Remove the poured metal section from the ring model & solid plug, this will be a separate, removable part of the mold. If stuck, a very gentile tapping with a light weight hammer on the steel plug down and away from poured top will usually loosen the ring. Excess poured metal should be filed away. File back to the exact edge of the ring top. File the top piece so that it angles up and out away from the top of the ring. This will establish a draft on this top piece for easy removal in the future. Also notice the raised dimple on the shaft of the top piece. This is a positioning marker for the piece to fit into the mold frame correctly. It was created by using a ball bur to make a negative dimple in the (A) channel of the mold frame before pouring the top piece.

Figure 8: established correct angle on top poured section of the mold

Next step:
Paint all four sides of the top insert piece, that were filed, with nail polish. Do not paint nail polish on any surface that touches the ring. Fit the soft metal top piece to ring model (still on solid plug)

and put all back into aluminum mold frame. (put it in the mold half with locator pins in it.).

Note: Make sure the top mold piece goes onto the ring model in the exact same position as it came off. It is a good habit to mark (light scratch) solid center plug to indicate which side was in which mold half. This should even be done before the first soft metal part is poured. A decision must be made here whether to make a 3pc or 5pc mold based on the geometry of the ring and the undercutting of the front and back faces of the ring as it sits on the brass plug. I will discuss making a 5-piece mold to show how to make the side ports using channels (D and E) in the mold frame. Make sure to make locating dimples in these channels of the frame before poring them so that the parts can be put back into the same channels after they are poured. Pack this mold half with plasticine almost up to halfway point on ring model. Preferably all plasticine will be a little under the halfway point. Figure 9 shows the plasticine slightly lower (about 1.0 mm) than the inside face of the aluminum frame.

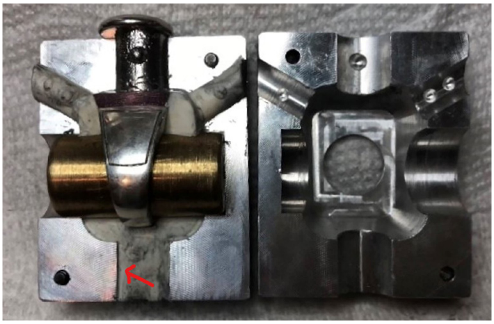


Figure 9: Preparing clay to pour the first side section of the mold

When the ring model, on plug, is half buried in plasticine, dust lightly with powder (I have used mica powder for this mold), and put the two mold halves together, keeping the half with plasticine, down, on the table. Plug all side holes of the mold. Plasticine or masking tape will do, this is just to keep molten soft metal from running out of the mold.

Figure 10: Pouring the first side section of the ring mold

Melt more soft metal in the ladle (do not overheat) and carefully pour it into mold through the hole inside. It's important to make a nice even pour so you get as smooth of a surface as possible against the ring model. Pour enough extra metal so a small mound of metal is raised above the outside of the mold frame. This excess will be important later. There should be a little extra soft metal above the surface of the aluminum mold. Remember when packing the other half with plasticine, you packed it just below the half-way surface. Pouring the half, without the locator pins, first. This makes filing smooth with a large file a little easier. When filing be careful not to file any aluminum, (this could cause flashing in production). The soft metal will permanently stay in the aluminum mold.

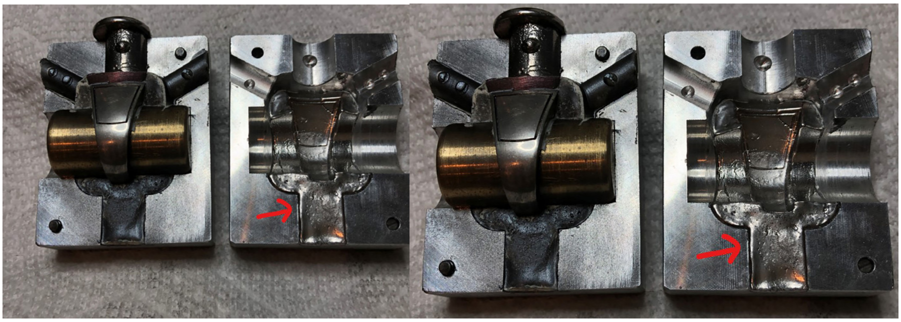


Figure 11: Poured first side section of the ring mold

Separate the two mold halves when the metal has solidified. Remove all plasticine. Separate the newly poured half from ring model and previously poured top piece. With a large, coarse file, smooth and level all excess soft metal on the inside of newly poured half. When this half is filed smooth, paint with nail polish the filed areas of the soft metal. Put ring model (still on solid plug) and soft metal top piece in place in mold (side (A). All soft metal that is visible and has been filed should be painted with nail polish. There should be no plasticine anywhere.

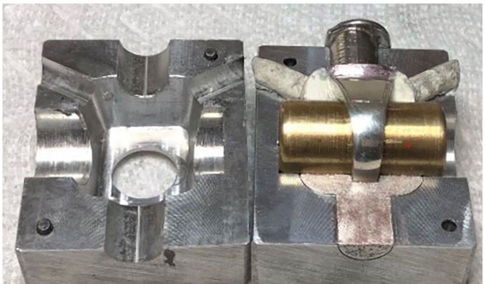


Figure 12: Prepared first side with clay and nail polish to pour side section 2 against

Dust lightly the assembly with powder and put both halves of mold back together. At this point you want the aluminum mold halves not to be touching. This can be accomplished in several ways: a little bit of plasticine on the aluminum only, or a couple pieces of a business card between mold halves, works well. The desired space between the two halves should only be 0.25 mm to 0.50 mm. This space will be eliminated later, after the final pressing. Seal up all holes on edges again with masking tape or plasticine. With the previously poured side down you're now ready to pour the other side. Follow the same procedure as previously, again, leaving a small mound of soft metal outside aluminum mold frame. Remove all tape, plasticine and nail polish at this point, separate two halves. If both halves look good without any large voids or wrinkles it is time to pour the two side channels (D and E) to complete the 5-part mold. Paint all of the surfaces that will be exposed to the new poured metal with nail polish to prevent them from melting together. Again, pour each side channel and leave a bit extra button of metal.

Figure 13: Prepared pre-poured sides sections to pour channel sections D and E

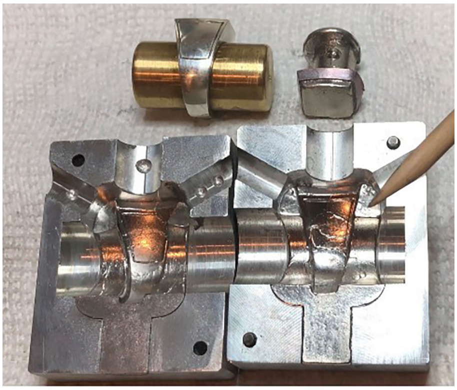


Figure 14: Pouring channel sections D and E

Remove the tape and rubber bands and open the mold. Take note of the locating dimples for each of these pieces Figure 15. You don't want to place these in the wrong channel when assembling the mold to prevent damage to the parts.

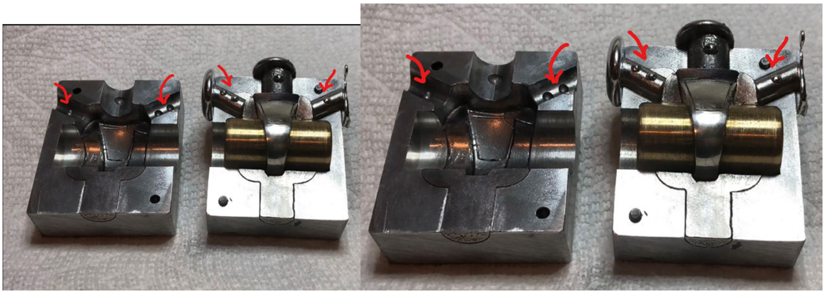


Figure 15: Poured channel sections D and E with locating dimples

Assuming all poured parts look good (no voids, metal flow marks next to ring, etc.), and you have filed away any extra unneeded metal, the mold is ready for the final pressing. Make sure paper or plasticine used as a spacer, previously, is now removed. Warm up vulcanizing press to approximately 25-degree Fahrenheit below the melting point of soft metal used. I am using a Belmont 281 Tru alloy that melts at 281 º Fahrenheit, so a temperature of 250 to 260 º Fahrenheit would be a good target for your press to be heated. A good way to check is to put a small chunk of soft metal in the vulcanizer and screw it down to apply a very light pressure to it. Leave it alone for a good bit to see if the temperature is too hot and it melts. I don't recommend trusting the dials on a vulcanizer, as you can see in the photo the dial is set just above 200 º Fahrenheit. I tested mine with a small piece of 281 metal and found this to be the correct setting for my press. Only when you are sure the vulcanizer is at the temperature desired, and holding steady, are you ready for pressing.

Figure 16: Ring mold being pressed in a heated vulcanizer

Place mold in vulcanizer, laying on one side. Tighten the vulcanizer screw slightly. When the mold is held in place by pressure of clamping in vulcanizer, then put the C-clamp on. One C-clamp should cover the top plug opening and the sprue opening and the other C-clamp should be over the (D and E) channel openings. Tighten the C-clamps slightly and make sure they do not impede the vulcanizing press from tightening down on the mold. I have had to put aluminum blocks on top and bottom of the mold to give the C-clamps enough clearance. Slowly tighten C-clamps and vulcanizer press as mold heats up. This pressing could take up to 2 to 3 hours and should be watched carefully during this time. If soft metal melts, the temperature setting is too hot. If metal does not soften slightly allowing it to be pressed, temperature is not hot enough. Finding the correct vulcanizer temperature setting is tricky, and extreme care must be taken to make sure metal does not melt. The extra soft metal mounds on the outside of aluminum mold should be slowly disappearing, creating pressure against ring model. C-clamp pressure will be also moving soft metal. This will force the soft metal to pick up all the fine detail and fill sharp corners of the ring model.

After the mold has been pressed completely the mold can be removed and allowed to cool to room temperature. Some people recommend turning off the vulcanizer and let the mold cool down to room temperature while under pressure. The little bit of space left a few steps ago, between the two aluminum halves should be eliminated now. Once cooled, the mold can be opened. Sometimes the mold halves will be tough to open. Gently tapping a metal wedge (a knife blade will even work well), between the two mold halves will generally pop the two halves apart. If any of the poured metal parts got stuck together, and do not separate properly, this indicates the vulcanizer was too hot or there are undercuts in the model. All is not lost. The part that has extra metal can be filed back to where it was, and the part with metal missing can be re-poured and re-pressed. A minor setback to be eliminated with experience. Sometimes this can be fixed with a soldering gun (iron) and a little extra soft metal melted in, then filed and final re-pressing completed. If an undercut has caused the mold to not come apart usually a small part of the soft metal will break free when enough force is applied.

Once the undercut area is discovered it can be fixed in the model to relieve the issue. This may consist of filling a bit of a draft angle in that area or filling the undercut with a bit of steel epoxy. Either method can work on small areas and care must be taken not to disturb the position of the model on the plug or in the mold. If the undercutting is a larger area then it may be best to remove the model and repair it with the proper draft angles and start again. When all parts look good, you now have a mold that can be tried and used.

Carve a sprue channel in both mold halves. A larger cylinder bur in a flex shaft works well. Try to make the sprue channel, even, straight and smooth. Put the mold pieces together, with the solid center plug, and inject with plastic (or wax). This will give you a solid ring. If this is the desired product then the mold is completed.

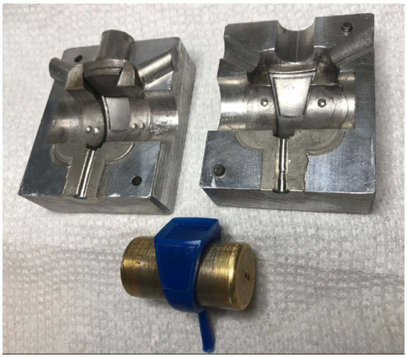


Figure 17: Finished solid ring mold with wax injection

Making the Core, if a hollow-back ring is desired, proceed as follows:

Separate all mold pieces (two mold halves and top pieces). On the aluminum halves, you'll want to carve in a couple of locator dimples into the soft metal as indicated in Figure 18, is all that is required. I used a ball bur to cut 2 dimples on one side of the mold and 4 on the other. This will keep the inside pieces (yet to be poured) from shifting out of place when in production.

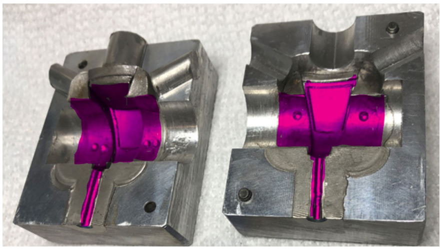


Figure 18: Prepared mold for pouring a hollow core with locating dimples

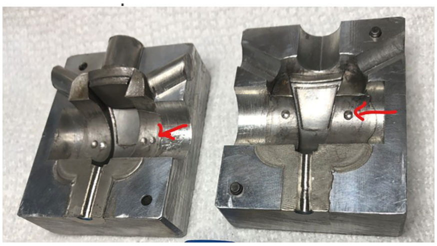


Figure 19: Prepared hollow core mold with nail polish to protect the metal from fusing when poured

Now, paint the ring cavity (the two halves, side channel parts and top piece) with nail polish. Also paint nail polish on entire soft metal area that was in contact with center plug. Soft metal areas that are in contact with metal (soft or aluminum) need not be painted. When the nail polish has dried, put the mold halves and top pieces together, insert a brass “v-plug” of the correct diameter in the center area of the mold channel (C) where the solid plug has been. You’ll notice that the brass “v-plug” has a taper to it. Put the larger end into the mold first. This will keep it from falling out in production, after the inside soft metal parts are in place.

Position the brass “v-plug” as in Figure 20, with the pointed edge on center under the top of ring cavity. Pour some molten soft metal into the void area on both sides of “v-plug”. Try not to pour too much metal over the end of the “v-plug”. Any excess can be cut off later. A jewelers saw with a spiral wax cutting blade works well. Do not cut into the ‘”v-plug”, leave a bit of extra soft metal on the end and file it away to the brass. Most machined “v-plugs” that I have purchased have some thickness at the top of the wedge. I like to file this to a sharp edge which will help later when the 2 halves need to be spit and broken apart. This should be done before poring the soft metal as in Figure 21. I may refer to these “v-plugs” as split plugs at times.

Figure 20: Brass spit plug slide centered correctly inside mold before pouring the core

Figure 21: Brass split plug slide, on the right side, filed to a point.

When solidified, separate the mold parts. You should have a pretty good representation of the ring apparent on the piece that poured. You will now file, grind or cut away at this poured soft metal ring, creating a negative area (when the mold is put back together) for plastic to be injected into. Here's how to go about this step. If there is any soft metal that has filled the bottom of ring shank area, and is overlapping brass v-plug, cut it off as illustrated in Figure 22.

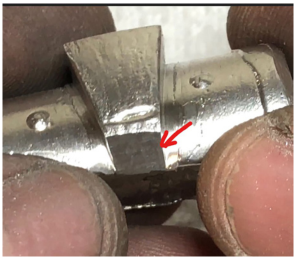


Figure 22: Ring shank core ends filed at an angle to meet the brass slide

Now remove soft metal from the ring sides going down to plug (darkened area in Figure 23) This will create the edge of the ring that rests against the finger. When more of the soft metal is removed, the thicker the walls on the ring casting will be. I recommend taking off at least 1.0 mm from these two sides, so as not to create a knife edge on the finished ring. That would not feel comfortable to wear. I have targeted my wall thickness on this example to 1.25 mm. This metal can be taken off however you feel most comfortable doing it. On a ring that has flat sides, I use a flex shaft with cylinder burr and take about a 1.0 mm cut, do not take too much off at any point. Remember, you can always take off more, but you can't add it back on. If too much is removed the part will need to be re-poured.

Figure 23: Prepared split plug core for removing side walls to establish wall thickness

I used a couple of cylinder burs at different angles and a large separating disc to grind away the initial metal from the sides. Using the vertical cylinder bur was the most effective to follow the angle of the ring and not disturb the metal on the center plug. It is recommended not to grind all the way down to the center plug (stop a fraction of a mm short) this will prevent flashing on the outside edges of the injected ring.

Figure 24: Cylinder bur for removing metal to establish wall thickness 001

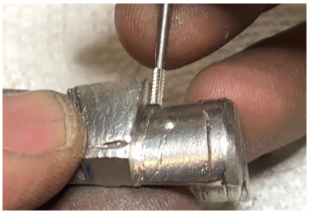


Figure 25: Cylinder bur for removing metal to establish wall thickness 002

Figure 26: Cylinder bur for removing metal to establish wall thickness 003

A small square file can be used to carefully smooth edge that will ultimately be against finger. When these sides are removed evenly, go on to the top and shoulders of the ring. This need not be as thick as the sides that touch the finger. I recommend taking off at least 0.50 mm on these sides. I have made walls as thin as 0.30 to 0.40 mm in the past, for plastic injection, to achieve a lighter weight casting. Plastic injection can achieve these thinner walls if desired. Removing more soft metal results in the thicker the side walls and consequently, the heavier the end casting.

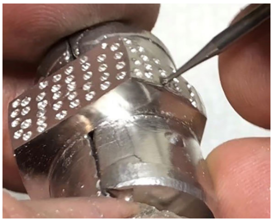


Figure 27: Making witness marks

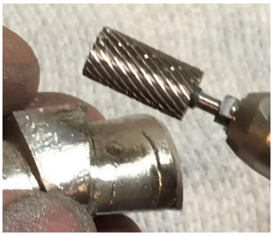


Figure 28: Removing witness marks

Figure 29: Removed witness marks

A helpful hint to aid in taking off equal and even amounts of soft metal, on these sides; With a round bur, in a flex-shaft, gently, at random cut numerous little "dimples" all at approximately the same depth. I refer to these as "witness marks". In this case I used a 1.6 mm ball bur and made a dimple with it half its diameter which should give me a wall thickness between 0.80 mm to 0.90 mm,. Then use a hand file or rotary file and remove desired amount of soft metal from these areas. The round dimples will slowly start to disappear. Do this evenly and uniformly. The purpose of the witness marks is to help keep the side walls an even thickness. Without some sort of guide, keeping the amount of metal removed, equal, is difficult. At any point, plastic (or wax) can be injected into the mold to check the progress of removing metal. Cutting cross sections of the plastic, with a sharp knife, and comparing both sides of the ring is quite helpful. The top area is the final spot to be filed away. The order just indicated for metal removal, from center plug, is completely arbitrary, and doesn't make any difference as to which sequence you choose.

The objective is all sides must have metal removed. When you have removed all the soft metal from the plug that you plan on taking off, it's time to think about a texture for the inside of the ring. You may choose to leave it smooth, or put on a texture. Leaving it smooth shows any minor imperfections, casting bubbles, etc. A high polish can be achieved on the bismuth metal with fine abrasive silicon rubber wheels. Putting on a texture will hide any of this, and make finishing of gold ring easier. One of the easiest textures to put on is a "stipple" finish. With a round burr (your choice of size) in a flex shaft, very lightly touch down all over entire area (don't take off much). This will produce a pebble type of finish. Walking a flat graver with a wriggle cut can be a nice finish if done properly. Florentine and numerous textures can be utilized. Hand engraved patterns can give nice details and a signature finish. Again, it's your preference but whatever you do, don't do it deep. After the inside of the ring is completely textured, you're ready for the final step.

Figure 30: Smoothed core for hollow ring

The inside soft metal plug is now ready to be split in two. The only thing that connects the two halves now should be the soft metal under the top area of the ring. Do not saw this as you will have plastic or wax fill any saw cuts creating a heavy parting line. This piece should be broken so that the two halves will meet a perfectly as possible. To do this, turn the piece up side down and gently tap a wedge into void from the "v-plug" as in Figure 31. First I use a small drill or ball bur to drill a series of dead ended holes into this "v" just under the top. This helps make a cleaner break. I prefer a thin butter knife Figure 32, a wooden wedge like the one from your ring clamp could also work. Do not clean up this break, it will only create flashing.

Figure 31: Drilling into underside of core to help break it into two halves

Figure 32: Breaking the core with a knife

Figure 33: A clean break splitting the core into two halves

The hollowed ring metal mold is now completed. Silicone mold release spray can be used, very lightly, or a light dusting of powder might also help. In general, very little (if any) powder or silicone should be necessary. Care must be taken when handling these molds putting the pieces together and taking them apart. They can be scratched or dented if mishandled and can also break if dropped. Putting them into the wrong place in the mold frame and closing them can damage the parts so pay close attention and use the locating dimples that have been created to properly align the parts of the mold. Once you have the ring injected and removed the top and side mold pieces the injected ring will still be on the split plug parts. Carefully slide the brass split plug from the plastic or wax ring and the top soft metal plugs.

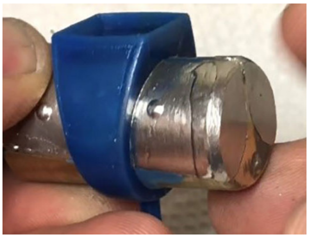


Figure 34: Injected hollow ring in wax

Figure 35: Removing brass slide

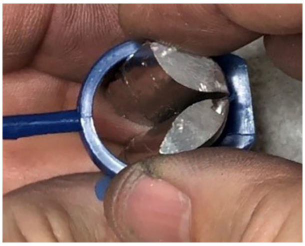


Figure 36: Removing core 001

Collapse the two halves of the soft metal split plugs one at a time. There should be enough clearance to remove them. If not, some metal can be removed from the inside of each half of the plug, see Figure 39 where highlighted. This should not affect how the pieces fit onto the brass split plug.

Figure 37: Removing core 002

Figure 38: Removing core 003

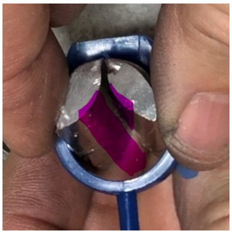


Figure 39: removing core 004

This mold can be used for either a solid wax or a hollowed wax as desired.

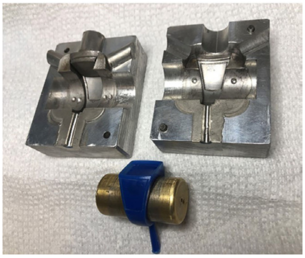


Figure 40: Finished solid ring mold

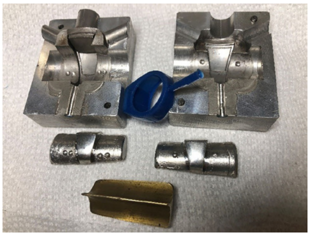


Figure 41: Finished hollowed ring mold

Making a flat mold

Making flat molds are easier than ring molds in general. One-sided molds would be the easiest as the bottom side of the mold can just be a block of aluminum that matches the top side of the mold frame. I will concentrate on making a two-sided mold. The types of pieces that would be made with this technique are pendants, charms, lapel pins, cufflinks, and other flat objects. I have made a few coins with this method that have turned out quite nice for a cast coin. One of the main obstacles in making a two-sided mold is how to center the model in the mold frame. Albert M. Schaler wrote about a technique in his paper for the 1998 Santa Fe Symposium, Pressed Soft Metal Molds, where he uses dental stone to cast against a model that had been blocked off with clay to establish a parting line. The dental stone can apparently withstand the heat and pressure when the soft bismuth alloy is pressed around the exposed model. I am not familiar with this technique having never tried it but I'm sure it has some merit if someone would like to try it.

The technique that I like to use is one we developed at Combine International where I first learned the pressed metal mold process. We had developed quite a few coins, pendants and pins for a collection and this is the method we developed to make it easier for us to center the model in the mold frame. We would make up a lot of the models from photo etched plates that we had made from Owosso Graphic Arts, Inc. Photoengravers, in Owosso, Michigan. They are still in business and make very nice magnesium, copper, and brass dies. Figure 42 is an example of a magnesium etching from Owosso Graphics.

Figure 42: Magnesium photo-etched plate from Owosso Graphics, Inc.

We would make up black and white art work the size that fit our mold frames. These came out very 2 dimensional as the photo etching would only give us one level. I would carve into the magnesium to give the models more detail. The lettering and other graphics would come out quite nice and had a bit of a draft on them which would release well from the mold after it was pressed. I have decided to make a coin for this paper to commemorate Eddie Bell and The Jewelry Symposium. Since I wanted a couple different levels in the coin, I decided to build the model in Rhino then have it a rapid prototype made of it on a ProJet 2500. I then had this model cast in bronze. I kept the model of Eddies face separate so that I could sculpt the detail in and add it to the model when I was happy with it. When I use to have the magnesium plates made for a 2-sided coin, I had 2 of them (1 front and 1 back) etched and would line up the holes in the corners that I would later drill out to match the locating pins of the mold frame. In this case I made a two-sided model that would be cast, finished and then suspended in the middle of the mold frame.

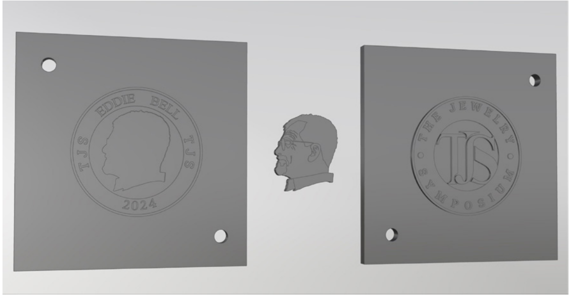


Figure 43: CAD of coin model

Figure 44: Bronze castings of coin model

After carving a wax of the profile and casting it in silver it did not fit into the bronze coin model so I ended up carving it into the bronze casted profile to achieve the detail and the proper fit.

Figure 45: Finished bronze model for TJS coin, this model is 2-sided

I had a mold frame CNC milled from Bob Aletto in Boca Raton, FL. He also cast the final set of bronze castings that I used for the model. He made larger holes in the model to accommodate the locating pins in the mold frame that he machined.

Pouring the flat metal mold

The steps for making the mold are similar to making a ring mold. The plasticine clay is usually not needed. The model is sandwiched between the two halves of the mold frame. It helps to put a thin spacer between each mold half and the model to allow a bit more soft metal to protrude over the surface of the mold frame. Pour both halves and leave a button of metal on tops for pressing.

Figure 46: Preparing to pout the coin mold

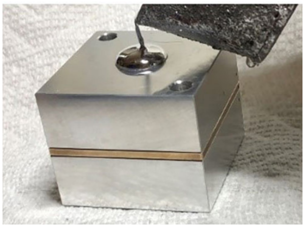


Figure 47: Pouring 1st half of coin mold

Figure 48: 2nd half poured

If the poured halves are without voids and defects the mold can be pressed in the vulcanizer. It is a good idea to put a bit of light machine oil between the mold halves and the model to help in pulling the mold apart after pressing. Put light pressure on the mold at first so that the heat can penetrate fully into the mold. Apply pressure in small increments to insure the soft metal fills all of the detail. This mold took about 3.5 hours to press completely.

Figures 49 and 50: Finished coin mold with Eddie Bell portrait side (left) and TJS side of model (right)

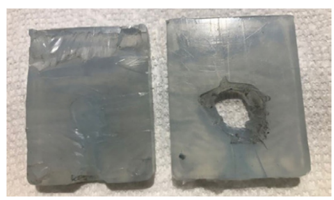
I was able to inject wax into the mold. I was not completely happy with the results and would make some changes to the model to make this a proper production mold. I would add a draft of about 10° to the lettering to help the mold release easier. The thickness between the lowest part of the coin on both sides turned out a bit thin and would thicken this in the next model. I was able to put a 0.25 shim between the mold halves that helped with the wax injections. The wax injections will not give me the quality that I need in a coin since the waxes were sinking in some spots due to cooling and not achieving enough pressure. I intend to plastic inject these for production so I will make these changes to a model for the body of the coin. I will be able to use the sculpted profile in the new model as it can be removed from the original. The added thickness will also allow me to machine fly cut the mold halves after pressing to give me a tight fit for plastic injection. The final coins will be presented at The Jewelry Symposium in May of 2024.

Figure 51: Finished coin model showing wax injections of both sides of the coin

Hybrid molds with soft metal

I would like to show another technique that was born out working with soft metal molds. We were working on some large waterfall style rings which had a lot of undercuts and gallery work. The production orders where in the 50K range and all made of 10 karat gold. Trying to maintain as low as possible weight that was consistent was quite a difficult task. We blocked off the gallery in the models with a steel epoxy and rubber molded the rings on a brass plug. After cutting open the mold we inserted a split plug and poured a core of soft metal into the rubber mold. I was able to shave the core to a very thin wall in the same way as I showed earlier in making the hollow version of the ring mold. The rigid core allowed us to inject the molds without excessive pressure and we saved close to 2 dwt on average per ring. I don't have an example of this type of ring mold but would like to show a simple version of the technique.

I also use this technique to hollow out high detailed wax carvings. It can be a challenge to hollow a solid wax carving to a consistent thin wall without damaging the wax. It is even harder to hollow a solid casting which I have encountered in my career when a piece that has already been casted solid and a decision was made to make it into the lightest version possible. I had carved the profile for the previous coin mold and had Au Enterprises make a mold and cast it in silver. I am using this silicon mold to demonstrate this method. I start by cutting out the back side of the silicon mold.

Figures 52 and 53: Silicon mold of wax portrait for coin (left) and silicon mold cut out for pouring a soft metal core (right)

When pouring the core put a steel block on top of the molten soft metal button so that it flattens out even with the outside flat surface of the mold. Start by cutting back the edge of the core to establish the outside wall. I targeted a 0.50 mm to 0.60 mm wall thickness.

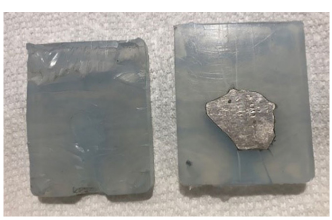



Figure 54 and 55: Silicon mold poured with a soft metal core to make a hybrid mold (left) and hybrid core with outside walls removed (right)

Once the wall is established you can start to cut the witness dimples in the surface of the core. I used a 1.10 mm ball bur to target a 0.60 mm wall thickness.

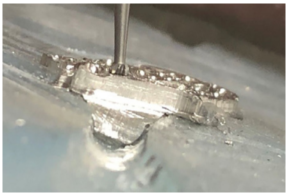



Figure 56 and 57: Hybrid core with witness marks (left) and cutting witness marks into the hybrid (right)

When you have the witness marks removed the mold can be injected with wax to identify any thin areas Figure 58. The soft metal can be marked through the wax and more metal removed from those areas of the metal core. Once you have a wall thickness that you like the core can be polished with a fine grit polishing silicon rubber wheel. Figure 60 shows a comparison of a solid wax and a hollow wax from the same mold.

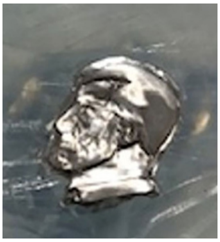



Figure 58 and 59: Wax showing thin spots (left) and finished hybrid core (right)

Figure 60: Hybrid solid and hollow wax injection

New possibilities

I always look for ways to combine different techniques and technologies to come up with new solutions. Pressed soft metal molds may have had its hay day and may become obsolete especially with the advancements in direct casting from Rapid Prototyping as well as direct metal prototyping. I still think the technique has merit for a lot of projects for all types of jewelry manufacturers. Maybe some new techniques can be combined with the new resins for Rapid Prototyping. I have done a little bit of experimenting with this. I tried a press metal mold on a resin made from my inexpensive Anycubic prototyping machine. I was visiting JCI in Kentucky to research their pressed metal mold techniques. With their help we poured and pressed this mold half directly to a resin part. I was surprised at the results. The lettering came out nice. The face had some voids in it which could have been caused by a chemical reaction from the resin when the molten bismuth was poured and then pressed under heat.

Figure 61 and 62: Resin prototype of coin (left)
and soft metal mold pressed against a resin model (right)

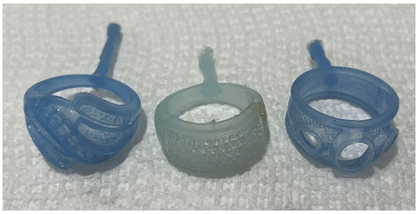
I think there are some good possibilities here and maybe with some of the new resins designed for direct rubber molding there could be better results.

One possibility that I have thought of is making split plugs from resin. These could be used to make hybrid rubber molds or even soft metal ring molds for hollowed rings since there is not a need to press the metal at this stage. Brass split plugs are expensive and hard to machine. This could be a quick way to make different size split plug slides. Maybe instead of pouring the core it could be made in cad with intricate designs that would be imprinted on the inside of the ring. Hopefully these ideas may spark someone to try and push the boundaries even further to come up with viable techniques to create new things.

Examples

I would like to show a few examples of some pieces that have been made from pressed soft metal molds. Some of these are close to 30 years old from when I worked for Combine International in Troy Michigan in the mid 1990's. There is a flat 2-side coin pendant, a few gents rings and womens rings that have been hollowed to thin walls under 0.5 mm thick. A couple of very thin pieces that would be very fragile to produce in a rubber mold.


Figures 63 and 64: Two sided pendant for 1996 Pontiac Masters (left), fragile thin earring and pendant (right), Combine International, Troy Michigan




Figures 65 and 66: Three thin-walled ladies rings (left), three thin-walled gents rings (right), Combine International, Troy Michigan


Figures 67 and 68: stipple finish on the inside of ring (left), following nugget valleys inside ring, Combine International, Troy Michigan

I have a few examples from a recent visit to Jewel-Craft, Inc. (JCI) in Erlanger Kentucky. They have a few metal molds that are 100 + years old. It was something to see and actually wax inject some of these molds. JCI still makes soft pressed metal molds and combines CNC milled parts in some of them. They do some tricky things to make emblematic jewelry like Class rings. They use some metal molds to make water soluble wax cores which fit into other molds and wax or plastic is injected around the core. They get some very precise hollow castings with this technique. My thanks go out to Ross Wesdorp for letting me spend the time at their factory and sharing their history and knowledge. They are one of the few factories that continue to work with these types of pressed soft metal molds.

Figure 69: Round mold with five inserts for injecting a 4 prong stone setting, from 1930s era, Jewel Craft, Inc. Erlanger, Kentucky

Figure 70: Six sided mold with five parts for wax injection from early to mid 1900s, Jewel Craft, Inc. Erlanger, Kentucky

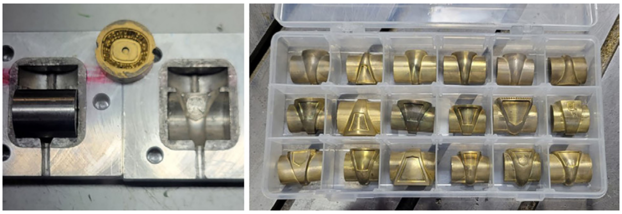


Figure 71: Pressed metal mold with CNC milled brass inserts for top (left). Many different ring shank profiles, CNC milled for class rings (right). These would be pressed into the soft metal molds. Jewel Craft, Inc. Erlanger, Kentucky

Figure 72: Pressed metal mold with CNC milled plug and top insert for a signet ring that has detail engraved on the inside and outside of the ring. Jewel Craft, Inc. Erlanger, Kentucky

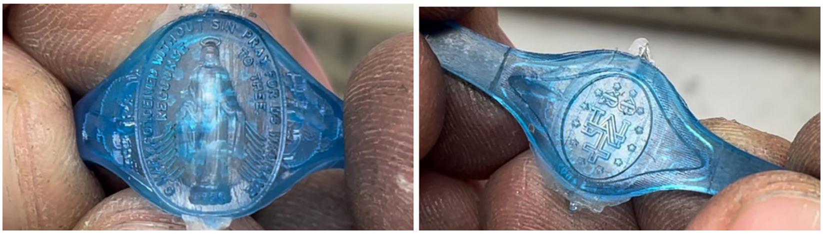


Figure 73: Plastic injected ring from the mold in Figure 71. This type of detail is difficult to achieve with a rubber mold. Rapid prototyping and casting directly can not give this fine of surface. Jewel Craft, Inc. Erlanger, Kentucky

Summary

I've been fortunate in my career to be exposed to many manufacturing companies and techniques. Pressed soft metal molds has stood out as one of the top techniques that I have seen and had hands on experience with. There are many approaches and variations to the method and a lot of people that use it have developed and expanded on the process. My motivation and hope is that these techniques be preserved and recorded so that future generations of jewelers can use them and also further develop them. It would be a shame for them to be totally lost.

List of Suppliers

- *Soft Metal Bismuth Alloys Tru 281*. Hi Tech Alloys, hitechalloys@oz.net, Belmont Metals https://www.belmontmetals.com/product/tru-alloy-281f-138c-low-melting-alloy/
- *Aluminum mold frames and plastic injectors*, A.B. Machinery, https://www.abplasticinjectors.com/
- *Plastic pellets for plastic injecting*. Romanoff International Supply Corp, https://www.romanoff.com/plastic-metal-mold-injection-pellets.html
- *Dye for plastic pellets*, Sun Chemical, 513-830-8500, https://www.sunchemical.com/
- *Magnesium and Copper dies*. Owosso Graphic Arts, Inc. Photoengravers https://www.owosso.com/products/

References

1. Instruction Manual for making Soft-Metal Ring Molds, by Bill Bartarla, United Precious Metal Refining, Inc. 1988
2. Pressed Soft Metal Molds, by Albert M. Schaler,Quondam Caster, Santa Fe Symposium 1998.

Acknowledgments

- My thanks go out to Combine International where I learned and helped develop these techniques and for their support in suppling examples.
- Thanks to David Yurman Enterprises for the support and opportunity to continue this type of work for the last 21+ years.
- Many thanks to Ross Wesdorp and his team at Jewel Craft, Inc. for welcoming into their factory and sharing their history, techniques and examples of their work.
- Thanks to Bob Aletto for machining the mold frame for the coin and casting the bronze models as well as the silver ring models.
- Thanks to Linus Drogs at AU Enterprises for his support in making the silicone mold for the Hybrid and silver castings,
- Thank you to Benedict Sin from Myer Company in Hong Kong for his support and sharing his companies techniques for making large multi-piece pressed soft metal molds.
- Thank you to The Jewelry Symposium Board and Jessa Cast for all their hard work in organizing and keeping this event going!