



Hadar Jacobson
Art in Metal Clay
hadar@pacbell.net • www.artinsilver.com

Updated 3/3/2010



Instruction Manual for Hadar's Clay™ Quick-Fire Copper and Bronze



Storage and Shelf Life

The powder clay does not require special storage. As long as it has not been mixed with water, it has an indefinite shelf life. Mixed clay should be refrigerated, wrapped with plastic food wrap inside a closed plastic box. Because Hadar's Clay™ is a new product, its shelf life when refrigerated is still uncertain, but it has been shown to last at least a few months when properly kept.

The shelf life of **un-fired** pieces is very long. There is no need to fire them right away.

Toxicity

None of the ingredients of Hadar's Clay is toxic. It may be unhealthy to inhale any powder of any kind. Use a protective mask and goggles when handling the powder, as well as when handling carbon.

Mixing Instructions

Also available as a video clip at www.youtube.com/artinsilver – select the video entitled “Hadar's Clay™ (Improved Formula) – Mixing.”

What you need:

- ❑ Small metal bowl or soup bowl
- ❑ Kitchen knife or any other mixing tool
- ❑ Distilled water in a spray bottle
- ❑ Olive oil in a spray bottle
- ❑ Plastic report cover (or work surface and plastic bag)
- ❑ Rolling pin (the wider the better)
- ❑ Scraper

Mixing the clay :

1. Shake the metal clay powder container.
2. Pour the desired amount of powder into the bowl.
3. Spray the powder with distilled water and mix with the knife. The powder will gradually form into crumbs.
4. Keep spraying and mixing until the crumbs separate from the walls of the bowl. Don't over-wet!
5. Oil both inner surfaces of the report cover and pour the crumbs inside it.
6. Roll the crumbs under the plastic cover using the rolling pin.
7. Fold the layer in half and roll again. Use a scraper to separate it from the surface. Keep folding and rolling until the layer is soft and smooth. Add oil if necessary.
8. When the layer looks shiny and creamy, the clay is ready to use.

The Consistency of the Clay

The clay is soft, pliable, does not crack when bent, and sticks well to itself. Discoloration (marbling) in copper clay is normal, and does not necessarily mean that it is mixed with bronze clay.

The photo on the right shows how readily the clay drapes when mixed to the right consistency.



Lubrication

The clay does not stick to the hands. As a release agent use olive oil only!

Drying

Pieces should be completely dry before firing. Dry them directly on a heating pan at 220-250°F (95-120°C). Other drying surfaces, such as Corian blocks, unglazed tiles, and pieces of sheet metal are better than playing cards.

Reconstituting

It is not recommended to reconstitute clay powder that is derived from sanding and filing. You can reconstitute solid pieces that have not been fired, after sanding the oxidized layer off of their outer surface. Always use distilled water to reconstitute clay. It can be reconstituted by grinding the dry piece in a dedicated coffee grinder and repeating the mixing process as described above.

Flexibility and Strength of Dried Clay

When dry, the clay may be a little brittle (much like low-shrinkage silver clay). Adding glycerin to the clay makes it more flexible. The surface is hard and resistant, and is best sanded with 150-grit sandpaper or a fine-grit sponge sanding pad (do not use medium grit!).

Shrinkage

After firing, pieces of copper, bronze, and steel clay shrink by about 10%.



Firing with Core Material

If you fire without using carbon (see below), firing with core material – including cork clay – is possible. If you fire with carbon it is also possible, but it is not recommended to fire too many pieces with core material in one batch.

It is recommended to hold for 30 minutes to 1:00 hour at 1000°F/538°C in a top loader kiln or 1100°F/593°C in a front loader kiln before continuing to the final hold temperature (see firing schedule on page 11, bottom right).

Flexible Clay

Mixing the clay with glycerin makes good flexible clay. See instructions for making flexible clay in my book: *The Handbook of Metal Clay: Textures and Forms*.

In this case, too, it is recommended to hold 30 minutes at 1000°F/538°C in a top loader kiln or 1100°F/593°C in a front loader kiln before continuing to the final hold temperature (see firing schedule on page 11, bottom right).



Flexible clay allows you to weave, fold, and knot with dried clay.

Repair

After firing, pieces can be repaired and re-fired as with silver clay. Copper and bronze **cannot** be repaired with a torch.

Combining Clays

Copper and low-shrinkage silver clay can be fired together, or even linked, as long as they are not in contact. To fire them in the same piece, fire the copper part first. To combine steel with another metal, fire the steel clay first.

When **bronze and silver** clay are fired together, sintering may not be complete and alloying may occur. (See more information in my book: *Silver and Bronze Clay: Movement and Mechanisms*.)

Copper and bronze clay that come in powder form are compatible and can be fired successfully in a single piece (See more information in my book: *Mixed Metal Jewelry from Metal Clay*).



Firing with Activated Carbon

Precious metals such as pure silver and gold can be fired in the air. They don't react with the oxygen under high temperature, and the oxygen ensures complete removal of the binder.

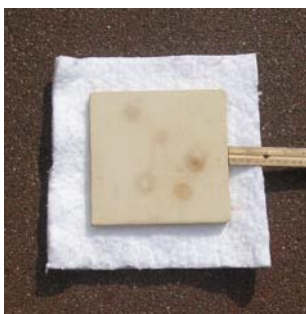
Base metal clays such as copper, bronze, and steel react with oxygen under high temperature to create oxides, which prevent proper sintering (the final bonding of the particles together). They are fired buried in activated carbon, which reduces the amount of oxygen in the kiln and inhibits this reaction. However, most organic binders used in metal clays need oxygen to burn off. If there is not enough oxygen (because it has been reduced by the carbon), the binder will not burn off and proper sintering will not be achieved. This problem can be solved by using a proper firing schedule.

Copper can be fired in the air under certain conditions (see firing schedules below).

It can also be fired in a box made from a fiber blanket. Other options are suggested below.

Making a fiber blanket box

When handling the fiber blanket it is recommended to wear a protective mask and gloves. An alternative to the fiber blanket will be discussed below.



1. Cut a square out of the fiber blanket, 2 inches longer than your kiln shelf on every side.



2. Cut away the 2" squares on all four corners of the blanket.



3. Fold the flaps upwards and pinch the sides together.

At first the walls may not stay upright. When placing the box in the kiln, support each side with a post. With every firing the box will become more and more stable, and eventually you won't need the posts.



It is important that the walls of the box are a little away from the walls of the kiln chamber. **Do not use a lid, and always leave the venting hole open!**

This box leaves the kiln perfectly clean after firing. The carbon stays contained in the box. It can be used many times.

Instead of a fiber blanket box, you can use a ceramic kiln shelf with posts arranged around it. The carbon stays contained in the box and does not spread in the kiln. You can add more posts to build a deeper box.



The Firing Process

Use coconut shell-based carbon, acid-washed, size 12 x 40.

Line the inside of the box with a 1/2" layer of carbon. Arrange your pieces on the carbon bed, avoiding the center. If you have a front loader kiln, avoid the front as well. There should be a 1/2" space between pieces, more for bigger pieces.



Cover the pieces with another 1/2" layer of carbon.

Place the kiln shelf on 2" posts. Place the box on the shelf. Make sure there is space for air flow between the top of the box and the top of the kiln chamber.

The firing schedules below apply to two popular types of kilns, both 8" x 8": front-loader muffle kiln, and top-loader brick kiln.

Firing schedule for bronze, mixed pieces of copper and bronze, and average sized pieces of copper

You can start the firing in either a cold or a hot kiln.

Top loader brick kiln: ramp at full speed to 1450°F/788°C

Front loader muffle kiln: ramp at full speed to 1530°F/832°C

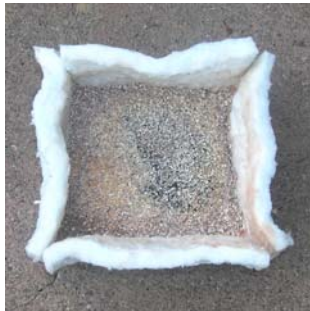
(You may find that this temperature is too high for bronze. If it is, flat bronze pieces will warp somewhat. You can either hammer them down after firing or lower the temperature.)

Hold for 1:00 hour.

For large pieces, add 1" layer of carbon and fire for 2:00 hours.

You can take the pieces out of the kiln while still hot and cool them in water, or wait until they cool down. Overnight firing works fine. If you take them out hot, use heat-protective gloves.

After firing, most of the carbon will have turned into ash. Pick up the fiber "box" from both ends and lift it out of the kiln. To retrieve your pieces you can pour the ash, hot or cold, through a sieve into a metal container. Discard the ash.



The black color on the pieces is not fire scale and can be easily removed.

Firing schedule for thick pieces of copper (works for bronze too)

Instead of a ½" layer of carbon, cover the pieces with a 1" layer.

Top loader brick kiln: ramp at full speed to 1470°F/800°C

Front loader muffle kiln: ramp at full speed to 1550°F/843°C

Hold for 2:00 hours.

Firing Copper Alone

Torch Firing

Small pieces of copper can be fired with a torch. Fire for 6 minutes and immediately quench in water. Dry thoroughly before working further on the piece. For a demonstration watch the video clip entitled "Torch Firing Hadar's Clay™ Quick-fire Copper" on my YouTube channel: www.youtube.com/artinsilver.

Hot Firing

Lay the pieces on a firing surface, such as a kiln shelf or a fiber blanket.



Ramp at full speed to 1690°F (920°C) in a top loader kiln, 1770°F (965°C) in a front loader kiln.

Just before the kiln reaches its goal temperature, place the firing surface in the kiln on posts, as high as possible. The pieces will catch fire immediately, and smoke will come out of the venting hole. It will only take a minute. Be sure to ventilate the area and wear a protective mask.

Hold for 30 minutes.

Wearing protective gloves, pick up the pieces with cross-lock tweezers while they are hot and quench them in water (pickle is not necessary). The copper oxide layer peels right off. If there is some copper oxide residue, buff, file, or sand it off. You can also heat the piece with a torch until it's red-hot and immediately dip in cold water.

Warning: Copper can be fired in carbon repeatedly. In the air, though, it will eventually weaken and disintegrate. Similarly, the process of removing fire scale by heating with a torch should not be repeated too many times.



Dry the pieces thoroughly on a heating pan before starting the finishing process!

Adjustments

The firing schedule may have to be adjusted according to the type, size, age, and structure of the kiln. Adjustments can be made by increasing or decreasing hold time and/or temperature. Before you start firing your art work, it is recommended to fire test pieces.

Test Pieces

Make test pieces that are as close as possible your style in size and thickness. Dry them, and fire according to the instructions.

After firing, start buffing them with a buffing wheel. The photo on the right shows a piece with powder under a thin layer of sintered metal. This piece has not properly sintered.



After firing actual pieces, buff them on the back side. If they are not fully sintered, re-fire for another 2 hours. If they need repair with fresh clay, fire according to the original schedule.

Alternative Firing Methods



You can use a stainless steel rectangular box, 1/2" tall. Place the box on posts, so it's as close as possible to the top of the kiln, where the temperature is most likely to be highest, with at least 1" between the top of the box and the top of the kiln. When the bottom of the box is above the lowest heating element, the heat can flow underneath the box and upwards. Fill half the box with activated carbon.

You can also use a stainless steel mixing bowl. Place it on a post 2" tall.

Leave the venting hole open. If you don't have a venting hole, it is recommended to drill one. After cooling, remove or vacuum the ash on top of the carbon.

Arrange the pieces as follows:

- In one layer only
- With ½" carbon underneath and 1" above them
- Vertically
- With ½" space between them; more for thick or big pieces

Arranging the Pieces in a Front-loader Muffle Kiln

Pieces should be arranged along the sides and the back wall (avoiding the center and front).



Arranging the Pieces in a Top-loader Brick Kiln

Pieces should be arranged along all four walls of the kiln, preferably avoiding the center.



In a mixing bowl position the pieces at an angle, roughly parallel to the wall of the bowl.



Firing Schedule in a Steel Box

Ramp the kiln at full speed to 1470°F (800°C) in a top loader kiln, 1520° (825°C) in a front loader kiln. Hold for 2:00 hours.

If bronze pieces blister at 1550°F (843°C), gradually lower the temperature, but no lower than 1520°F (826°C).

Firing Schedules - Quick Reference Table

<p>For Quick-fire bronze, mixed pieces of copper and bronze, and average sized pieces of copper</p> <p style="text-align: center;">In a fiber blanket box</p> <p>Ramp at full speed to: 1450°F/788°C (top loader) 1530°F/832°C (front loader)</p> <p style="text-align: center;">Hold for 1:00 hour.</p>	<p>For thick pieces of Quick-fire copper (works for bronze too)</p> <p style="text-align: center;">In a fiber blanket box</p> <p>Ramp at full speed to: 1470°F/800°C (top loader) 1550°/843°C (front loader)</p> <p style="text-align: center;">Hold for 2:00 hours.</p>
<p style="text-align: center;">For Quick-fire Copper</p> <p style="text-align: center;">Without a box - Hot Firing</p> <p>Only for Quick-fire copper</p> <p>Ramp at full speed to: 1690°F/920°C (top loader) 1770°F/965°C (front loader)</p> <p style="text-align: center;">Hold for 30 minutes.</p>	<p style="text-align: center;">For Quick-fire Copper</p> <p style="text-align: center;">Without a box -Torch Firing</p> <p>Fire for 6 minutes and quench in cold water.</p>
<p style="text-align: center;">For mixed pieces of Quick-fire Copper and Bronze</p> <p style="text-align: center;">In a steel box</p> <p>Ramp at full speed to: 1470°F/800°C (top loader) 1550°/843°C (front loader)</p> <p style="text-align: center;">Hold for 2:00 hours.</p>	<p>For very thick or large pieces, pieces with glycerin, core material, or a lot of olive oil</p> <p style="text-align: center;">In a steel box</p> <p>Ramp at full speed to: (Ra1) 1000°F/538°C (top loader) or 1100°F/593°C in a front loader</p> <p>Hold 30 minutes to 1:100</p> <p>Ramp at full speed to: (Ra2) 1470°F/800°C (top loader) 1550°/843°C (front loader)</p> <p style="text-align: center;">Hold for 2:00 hours.</p>

Checklist

Question	Correct Answer
<input type="checkbox"/> Did I shake the jar before mixing the clay?	Yes
<input type="checkbox"/> Did I use distilled water when mixing the clay?	Yes
<input type="checkbox"/> Did I use any lubricant other than olive oil?	No
<input type="checkbox"/> Did I dry the piece thoroughly on a heating pan at 200-250°F (95-120°C)?	Yes
<input type="checkbox"/> Did I use core material or glycerin?	If you did, use the extended schedule on p. 11
<input type="checkbox"/> Does the thermocouple stick into the chamber?	Yes
<input type="checkbox"/> Is the thermocouple older than 3 years? Could it be rusty?	No
<input type="checkbox"/> Did I use a small ss box (2½" tall) or a big box (4½" tall)?	Small box
<input type="checkbox"/> Did I elevate the box to the top of the kiln?	Yes
<input type="checkbox"/> Did I use a lid?	No
<input type="checkbox"/> Did I leave 1" space between the top of the box and the top of the kiln?	Yes
<input type="checkbox"/> Did I leave the venting hole open?	Yes
<input type="checkbox"/> In a front loader, did I remember to lay the pieces along the side and the back wall?	Yes
<input type="checkbox"/> In a top loader, did I lay the pieces along all 4 walls of the kiln avoiding the center?	Yes
<input type="checkbox"/> Did I overcrowd the box?	No
<input type="checkbox"/> Did I leave ½" space between pieces?	Yes
<input type="checkbox"/> Did I leave more than ½" for thicker or bigger pieces?	Yes
<input type="checkbox"/> Are there too many hollow forms in the box?	No
<input type="checkbox"/> Was there silver in the box?	No
<input type="checkbox"/> Did I mix different brands of copper and bronze clay?	No
<input type="checkbox"/> Did I fire a test piece?	Yes, if I am not sure yet about the right firing schedule for my kiln
<input type="checkbox"/> Did I dry the pieces thoroughly before starting the finishing process or before enameling?	Yes
<input type="checkbox"/> When "hot-firing" copper, did I start with a cold kiln?	No