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## 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](http://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). Cooling the clay in the refrigerator 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.

## 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*.

If you fire with carbon, it is recommended to add 15 minutes to the first phase of firing flexible clay.

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



## Repair

After firing, pieces can be repaired and re-fired like silver clay.

## Firing Hollow Forms

Hollow forms should be fired with their narrowest side up. Prior to firing, fill them about a third of the way with carbon to avoid trapping oxygen inside them. If they have no holes to feed the carbon through, they may require re-firing.

## Combining Clays

**Copper and low-shrinkage silver** clay can be fired in the same box, 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*). However, they should be fired longer than pieces that are made of either copper or bronze (see firing schedule below).



## Firing with Activated Carbon

Precious metals such as pure silver and gold are fired in open air. They don't react with the oxygen in the air 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 completely. If the binder is not completely removed, there will be no proper sintering. This problem can be solved by using a proper firing schedule.



Use a stainless steel box, 2½" 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, coal based, acid washed, size 12 x 40. If you have a venting hole, leave it open. 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

Not all kilns fire the same way, and different kilns require different arrangements and firing schedules. Described below are firing schedules for two popular types of kilns – a front-loader muffle kiln, and atop-loader brick kiln.

**Front-loader muffle kiln.** This kiln has heating elements on three sides only. The temperature near the door is considerably lower than the temperature near the back wall, and the temperature on the bottom is considerably lower than on the top. The thermocouple, which is supposed to sense the temperature in the kiln, is located on the back wall, and the temperature displayed on the control panel reflects only the temperature around the thermocouple. The temperature displayed on the control panel is not necessarily the temperature near the door, or on the bottom of the kiln. Moreover, carbon is a poor heat conductor, so the temperature inside the firing box is lower than what is displayed on the control panel.

### 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).



**Top-loader Brick Kiln.** This kiln is made of kiln bricks and the door is on the top. The heating elements are on all four walls. Bricks keep the heat better than muffles. There is hardly any loss of heat and the distribution of the heat in the chamber is better.



### Arranging the Pieces in a Top-loader Brick Kiln

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



# Firing Schedules

## Firing Quick-fire Copper

There are three methods for firing Quick-fire Copper: hot firing, cool firing, and torch firing.

### **Method 1: Hot Firing Copper**

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



Leave the venting hole open. 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, heat the piece with a torch until it's red-hot and immediately dip in cold water.

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



## Method 2: Cool Firing Copper

Fill half a stainless steel box, 2½" tall, with carbon. Place the pieces in the carbon vertically, about ½" above the bottom of the box. If some of the pieces stick out of the carbon, cover them with 1" of carbon.



Place the box in the kiln on posts, as high as possible. Do not use a lid. Leave the venting hole open.



Ramp at full speed to 1470°F (800°C) in a top loader kiln, 1520°F (825°C) in a front loader kiln. Hold for 1:30 hours.

This is how the carbon looks at the end of the firing (left) and after the fire has died down (right).



Wait for the fire to die down or the box to cool down all the way, and take the box out of the kiln. Discard the ash. There is no need to dip in water unless you need to cool the pieces.

Large pieces will require more carbon and longer firing time. If the firing is longer, use a lid.

### Method 3: Torch Firing Copper

As with low-shrinkage silver clay, only small pieces (coin-size) can be fired with a torch. Fire for 6 minutes and quench in cold water. Again, dry thoroughly before starting the finishing process.

### Firing Quick-fire Bronze

Firing Quick-fire Bronze is the same as method 2 (cool firing) for Quick-fire Copper. Pieces of bronze and copper can be fired in the same box.

### Firing Mixed Pieces of Quick-fire Copper and Bronze

Firing mixed pieces is similar to method 2 (cool firing) for Quick-fire Copper and Quick-fire Bronze. For mixed pieces, cover the box loosely, with a stainless steel sheet or with fiber paper. 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 3:00 hours.

**Use this schedule when you fire both mixed pieces and single metal pieces in the same box! You can hold for up to 3 hours if necessary.**

### 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.



You can also try to gently bend the pieces with your fingers. If they break easily, buff the cross section, where the piece broke. The photo on the next page shows 2 different results.

The piece on the right shows a cross section that is full of powder. That means that the binder has not been completely removed.



The one on the left shows a cross section that is all metal. The fact the piece broke means that the sintering was not complete, i.e., the metal has not reached its highest density.

Whenever you are not sure of the results of a certain piece, it is recommended to fire a similar test piece along with it, placed in a similar spot in the kiln. After firing, test the piece as described above. If it is not fully sintered, re-fire your original piece.

### Firing Schedules - Quick Reference Table

<b>Hot Firing</b>	<b>Cool Firing</b>	<b>Torch Firing</b>
<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>Hold for 30 minutes.</p>	<p>For both Quick-fire copper and Quick-fire bronze</p> <p>Ramp at full speed to: 1470°F/800°C (top loader) 1520°/825°C (front loader)</p> <p>Hold for 1:30 hours.</p>	<p>Only for Quick-fire copper, small size</p> <p>Fire for 6 minutes and dip in cold water.</p>
	<p style="text-align: center;"><b>Mixed pieces</b></p> <p style="text-align: center;">For Quick-fire Copper and Bronze</p> <p>Cover the box loosely</p> <p>Ramp at full speed to: 1470°F/800°C (top loader) 1520°/825°C (front loader)</p> <p>Hold for 3:00 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, add 15 minutes to the first phase of firing
<input type="checkbox"/> Did I fill a third of a hollow form with carbon?	Yes
<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 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 tight 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?	Yes