



## Hadar Jacobson

Art in Metal Clay

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# Firing Base Metal Clay

Precious metals such as pure silver and gold are fired in open air. They don't react with the oxygen in the air, and the oxygen ensures the complete removal of the binder.

Base metal clays such as copper and bronze cannot be fired in open air because they do react with oxygen to create oxides, which prevent proper sintering (the final bonding of the particles into metal). 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.

So in a way, the activated carbon is both a blessing and a curse. On the one hand it enables sintering; on the other it interferes with the removal of the binder. I believe that with the proper firing schedule we can get around this problem.

But there is another twist to this. Not all kilns fire the same way, and different kilns require different firing schedules. I have been firing in two different kilns and have come up with two reliable firing schedules for them.

**In both kilns**, 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. If you are using a taller box (4½"), fill ¾ of the box with carbon so that the pieces are as high as possible in the kiln, where the temperature is most likely to be highest. When the bottom of the box is above the lowest heating element the heat can flow underneath the box and up. fill half the smaller box with activated carbon, and stick the pieces in it. For the first phase of firing cover the pieces with only ½ - 1" carbon. **Don't use a lid!** If you have a venting hole, leave it open. After cooling, remove or vacuum the ash on top of the carbon and add carbon to fill the box. Cover the box loosely with a lid and move on to the second phase of firing. You can plug the venting hole, but it's not necessary.



**In both kilns**, arrange the pieces as follows:

- In one layer only,
- Vertically,
- With pieces separated from each other by ½"; more for thick or big pieces ,
- As high as possible in the 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 that we see 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 center and front).

## Firing Schedule

### Phase I

Ramp at 1750°F (972°C) to 1100°F (593°C)  
Hold 30 minutes

Cool to room temperature

### Phase II

Full ramp to 1550°F (843°C)\*  
Hold 3:00 hours.



\* If bronze pieces blister at this temperature, lower the temperature to 1520° (827°C) .

Make sure the thermocouple sticks out into the kiln chamber. If it does not, gently try to pull it further into the chamber. When you place the firing box in the kiln, the box may push the thermocouple back into the wall. To make sure you did not push it back, take the box out, see if the thermocouple is in the same position as before, then put the box back in.

If your kiln is more than 3 years old, your thermocouple may be rusty and needs replacing. This can be checked at a local ceramic store.



**Top Loader Brick Kiln** is made of kiln bricks and the door is on the top. The heating elements are on all 4 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 4 walls of the kiln, preferably avoiding the center.

### Firing Schedule

#### Phase I

Ramp at full speed to 1000°F (538°C)  
Hold 30 minutes

Cool to room temperature

#### Phase II

Ramp at full speed to 1480°F (804°C)\*  
Hold 2:30 hours.



\* If bronze pieces blister at this temperature,  
lower the temperature to 1470°F (799°C).

### Adjustments

These two kilns, of course, are not the only ones available, and the firing schedule may have to be adjusted according to the type, size, age, and structure of the kiln. Adjustments can be made to either of the phases by increasing or decreasing hold time and/or temperature.



## Test Pieces

Before you actually fire your work, it's a good idea to make test pieces and do a trial run, to find the ideal firing schedule for your kiln.

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 right 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. Adjustments may be needed for the first step of the firing.

The one on the left shows a cross section that is all metal. The fact the piece broke with means that the sintering was not complete, i.e., the metal has not reached its highest density. Adjustments may be needed for the second step of the firing.

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