The Virtual Foundry
211 S Water St
Stoughton WI 53589, USA
www.thevirtualfoundry.com

Filamet™ FFF Metal Evaluation Kit

This kit provides everything you need to print, debind and sinter a *Pure Metal* part of your own. If you don't have a 3D Printer, you can use a handheld 3D printing pen for your evaluation.

You will need to have access to a 3D Printer (or 3D printing pen) and a Kiln that has a programmable controller able to reach at least 1100°C / 2000°F. (If you don't have a 3D printer or a 3D printing pen, pick up a low-cost pen to help you get started. Here's a link to one on Amazon.)

Kit Includes:

a. Sample of Copper Filamet™
b. Bag of Sintering Refractory Ballast - Talc
c. Bag of Sintering Refractory Ballast - Al2O3
d. Sintering Carbon
e. Example Green (not debound or sintered) 3D Printed Part
f. Example Debound and Sintered 3D Printed Part
g. Piece of Kiln Paper
h. Stainless Steel Sintering Crucible

The Evaluation Kit includes enough filament to print 2-3 Universal Calibration rings. This simple 3D model was created to help you dial in your printing and sintering processes. You can download the STL file here- https://thevirtualfoundry.com/universal-calibration-rings/

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How to Debind and Sinter 3D Printed Parts

Debinding

In the Debinding phase of the operation, the plastic that holds the filament - and then the print - together is removed through a Thermal Debinding Process. The Virtual Foundry's thermopolymer is designed to be cleanly removed from your part at temperatures between 800F/427C and 900F/482C. It's important to ramp the temperature slowly up to this point in order to avoid distortion of your part. For example, heating too quickly will cause the plastic to boil before it's removed from the part. This boiling action will create voids in the final sintered part.


Step 1-a


Step 1-b


Step 1-c


Step 4

The debinding recipe is simple.

1. bury your part in A2O3 (item c)
    a. Fill your Crucible (item h) part way with Al2O3.
    b. Place your green part on the initial bed of Al2O3.
    c. Now cover the part with more Al2O3.
2. It's important that at least ½" or 15mm of Al2O3 be on top of the part.
3. It's also important that all crevices are filled with Al2O3. You can do this by adding Al2O3 slowly and tapping the edge of the Crucible so the Al2O3 settles into place.
4. Place Crucible into the kiln
    a. Program your kiln to ramp to 900F/482C at a rate of 100F or 55.6C per hour.
    b. Hold at 900F/482C for 2 hours*
5. Cool to room temperature.
6. Empty your Crucible into a bowl that will hold at least twice the amount of material that you're working with.
7. Pick out your part.
8. Debinding Complete!

At this phase, the part will be strong enough to handle, but is still quite fragile. This is called a "brown" part.

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Sintering


Step 1


Step 2


Step 3 and 4


Step 5


Step 6

The Sintering Recipe is also simple:

1. Fill the Crucible half way with Talc (item b).
2. Gently place your part on top of this first layer of Talc.
3. As in the debinding step, add more Talc so it's buried at least ½" or 15mm from the top.
4. You will need to leave room at the top of the Crucible to add a layer of Sintering Carbon (item d).
    a. This Carbon becomes chemically active at higher temperatures and will combine with any oxygen present to become harmless CO2.
5. Add a ½" or 15mm layer of Sintering Carbon, then lay the Kiln Paper (item g) on top of the Crucible.
    a. The Kiln Paper's job is to minimize the amount of oxygen that reaches the Sintering Carbon.
    b. The Kiln Paper will conserve your Sintering Carbon so it may be used many times.
        i. If you have black carbon present after the sintering cycle, you know you have succeeded in keeping oxygen out of your sintering operation.
        ii. Also, any black carbon can be re-used indefinitely.
6. Now, place the Crucible in the kiln and program the kiln to slowly ramp to a temperature of 1925F/1052C for Copper, or 1625F/885C for Bronze, at a rate of 200F or 111.1C per hour. *
7. Let the Kiln cool to room temperature.
8. Empty your Crucible into a bowl that will hold at least twice the amount of material that you have.
9. Remove part and brush off the Talc.
10. Sintering Complete!

* We generally recommend running these cycles overnight on two separate nights.

At this stage your part will have the properties of pure Copper (or bronze), but will have a dull finish. We recommend that you work the part with a wire brush or wheel. A wire wheel on a bench-grinder will make quick work of improving the finish. Final cleanup with a rotary tool will help you get the details cleaned up.

From this point forward you can handle the part just as you would any other part made of the material you are working with. Appropriate metal finishing techniques have been developed since the beginning of recorded time. Your options are limitless. Buffing compound and a cotton buff work well to get you to a nice shiny part, but you can consult google for other metal finishing, antiquing and patina techniques that you may find interesting.