Tethonite®

96% Alumina

TĒTHON 3D

Tethonite High Alumina

Tethonite® is an authentic ceramic powder for use in powder/binder jet 3D printers. Tethonite powder and companion Tethon 3D ceramic binder is needed for best use. Tethonite is offered in four formulations, earthenware (terra cotta), stoneware porcelain, and 96% Alumina. Objects printed with 96% Alumina must be fired to 1700*C. Sintering lower is possible, however the parts will become less vitrified and more porous with lower temperatures.

Recommended PrintingTools

Wooden board for build plate

Fine brush to remove lose powder

Kitchen Stainer to sift used Tethonite

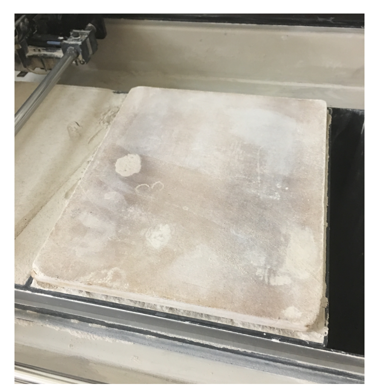
Wear respirator when handling unfired Tethonite

Convection oven for drying Tethonite

Wear safety glasses when handling unfired Tethonite

Printing

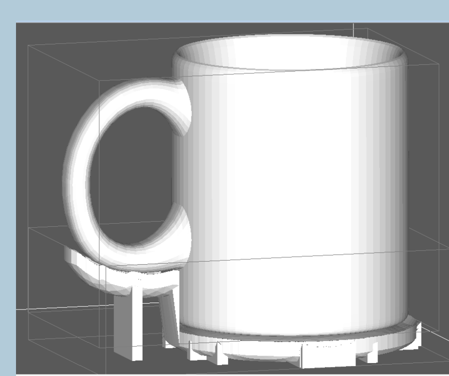
1. Load Machine with powder and Binder as directed by manufacturer.
2. Tethonite requires an additional build plate. A build plate can be a 3/4 inch wooden board the same area as the build in the printer. The 3D print will be created on this and used later to take out the printed objects. (A ceramic kiln shelf can be used if object are too fragile to handle in green state).
3. Determine whether print needs fixture. See examples listed below to determine if you need a fixtures.
4. Make sure Tethonite binder and powder settings are selected. (see binder / powder settings bellow)



Removing Part from printer

1. Lower feed bed.
2. Raise build bed to gain access to print.
3. Carefully remove excess powder using a soft brush. Do not touch the object at this point. It is better to leave excess powder around the object.
4. Remove board and print from Printer. Dry print on the board in the oven

Example of a Support Fixture: Handles on mugs need to be supported with a fixture.Fixtures are needed for unsupported areas, large flat areas, wide base, hollow interiors (with open bottom), fragile (thick to thin areas) prints, upside down pyramid (or prints that rest on a point). Bottom of print may be rough so determine best way to place print in file.



Post Processing

Drying Objects

Dry in a regular or convection oven at 210 degrees F (98C) for 1-12 hours. Drying time can be the same as printing time.

The printed object should be warm to the touch when finished drying. (Cool surface = wet powder). The parts will be very soft before drying in an oven. Do not try and pick up or touch the parts before they are dry. Printed objects gain strength while drying. Once they are dried you will be able to pick up most objects.

Removing powder after drying

Use caution while removing excess powder. It is better to move slowly.
Remove dust in a hood and wear protective gear.
Use brush gently to remove large areas of powder. Soft brushes will not damage Tethonite after it dries.
When using compressed air use a large tip for larger areas of powder and a smaller tip for finer details.
40 PSI will clean Tethonite well when it is fully dried.
If after, or while you are removing powder, the print feels wet or cool to the touch, place back into oven to dry further. Removing the powder in several stages can help Tethonite dry evenly.

Average Sintering Cycle
0-900 - 300*f per hour
900-2000 - 400*f per hour
2000-2269 - 270*f per hour

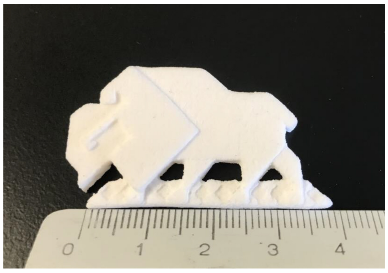
Joining multiple pieces together

After sintering parts can still be attached together. This is great when assembling larger objects Using a ceramic bisque- glue as directed by the manufacture will allow you to make more complex objects. Most of the ceramic bisque glues are made with aluminas and silica and can go to very high temperatures.

Technical Data

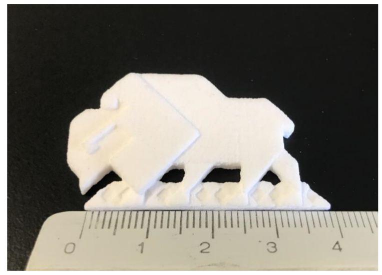
Optical photos of 3D printed alumina samples after sintering

Sample 1



1700 ^{o}C for 1 hour

Sample 2



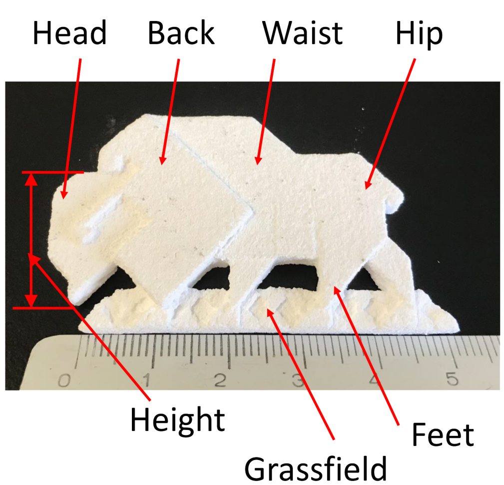
1700 ^{o}C for 2 hour

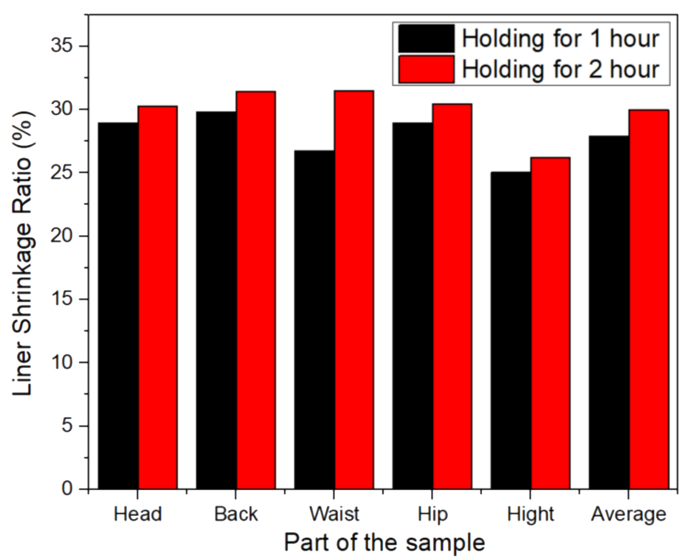
No.	Overall density (g/cm^3)	Relative density(%)
1700-1	3.43	86.1

No.	Overall density (g/cm^3)	Relative density(%)
1700-2	3.74	93.8

The density is determined by the Archimedes method, which may be a little higher than the real density, due to open pores.

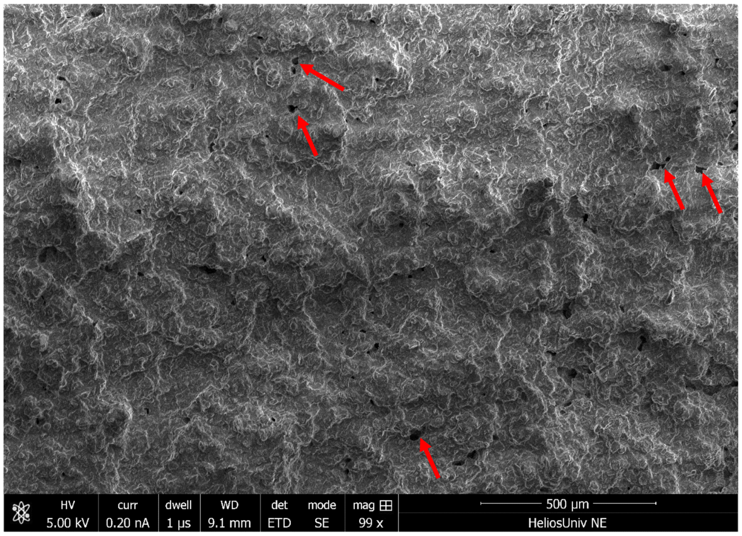
Liner shrinkage ratio of 3D printed alumina samples after sintering



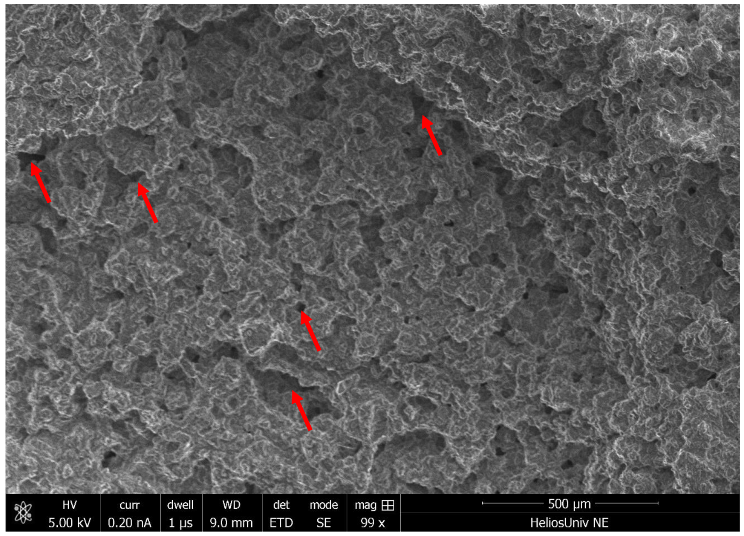


Scanning electron micrographs (SEM)

Sample 2: 3D printed sample sintered at 1700 ^{o}C for 2 hours.
Better sintering effect, fewer and smaller pores (red arrows) than 1 hour.
<u>Back/waist/head/hip appear to be sintered better than Feet/grassfield.</u>



Back, waist, head and hip



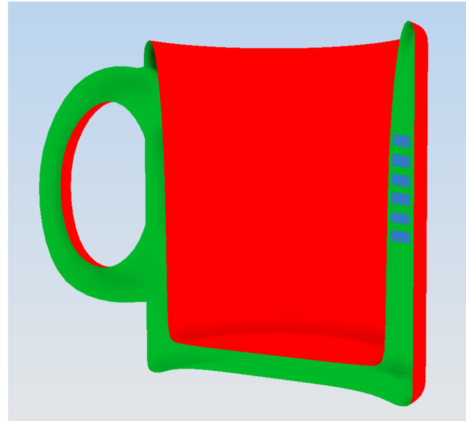
Feet and grassfield

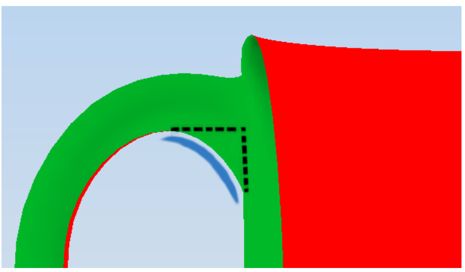
Does UNL have a sintering schedule they used?

Also can we use these images with their logo removed?

Design Guidelines

Maximum length in longest	Required wall
76 - 101mm or 3 - 4in -	3mm or 0.11in
101 - 127mm or 4 - 5in -	4mm or 0.16in
127 - 152mm or 5 - 6 in	5mm or 0.2in
-	6mm or 0.24in

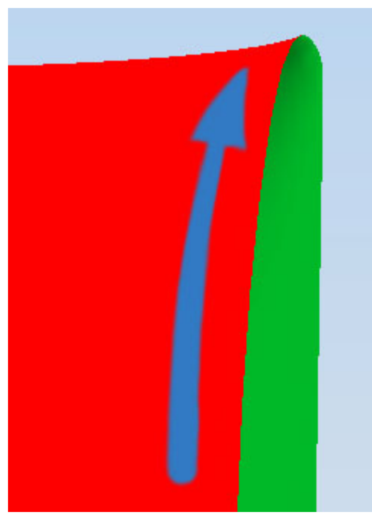




Bevel
For prints where shapes of the piece connect with each other it helps the print to have a beveled edge instead of a harsh angle. Beveling all right angles will decrease chances of cracking during firing.

Minimum wall thickness can vary +/- 1 mm from the above suggested wall thickness throughout the object. Tapering the wall thickness from thicker at the bottom to thinner at the top will increase the overall strength and stability of the object

(Thicker sections should not be on top of thinner sections. The wall thickness should vary from thicker at the bottom to thinner at the top. Larger forms may use this technique to to give the appearance of a thinner wall.)



Concave Base
For prints that are containers or container like it is best if bottom of the piece is concave.

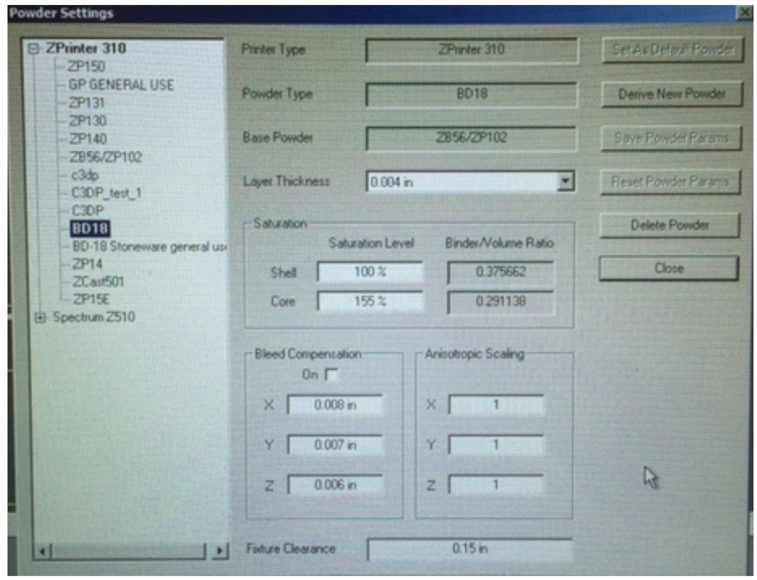
Minimum embossed detail
1.5mm min width and height

Minimum engraved detail
2mm mm width and depth

Loose powder escape holes 10 - 15 mm or 0.39 - 0.59 inches.
Making a model hollow instead of solid can help reduce the cost of a print. When doing this you may need to make a hole in the object to remove the excess powder from the piece. Unlike plastic materials, ceramics allow you to print a plug separately and seal the hole after printing.

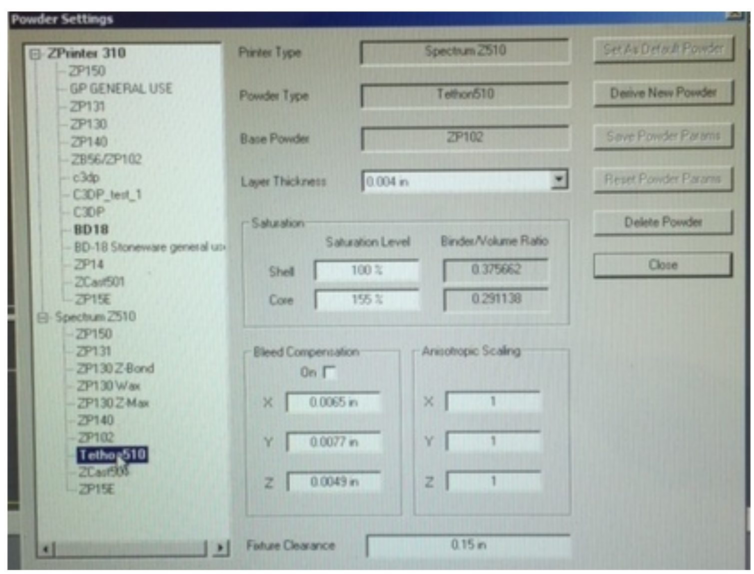
Binder and Powder Settings

Binder Settings: For Tethonite to properly work it needs its own specific binder settings. The most important part about the binder settings is to have it fully saturated in the core and the shell of the print. The more binder that is saturated into the print the stronger the object will be. These settings are examples on the Zcorp 310 and 510.



Zcorp 310 Binder Settings
Derived from ZP56/ZP102
Shell 100%   Core 155%

Zcorp 510 Binder Settings
Derived from ZP102
Shell 100%   Core 155%



Powder Settings: Tethonite can be printed in very fine layers. This results in very little visible print layers. The most common print layer is just .004 inches thick.

Troubleshooting

If binder laid down by the printhead is looking streaky or missing spots.

- Check Printhead for powder buildup.
- Check binder lines for blockage. Clear with bleach to remove possible bacteria buildup.
- Check to make sure the printhead has enough binder in it. Refill if necessary. Use this tool for refiling printheads http://www.inkowl.com/index.php?S=19&B=8&product=5668&p=product
- Inspect the 3D file for non-manifold geometry.

If printed object is weak and breaks in the green state.

- Allow print to dry longer in over after printing.
- Increase wall thickness of the object.
- Check Binder Saturation settings in your 3D printing software.

If cracks form during firing.

- Make sure your following the print guidelines.
- Increase wall thickness.
- Add additional supports to your object.
- Use bisque repair medium to fill in any cracks formed during firing.