Technical, Design, and Usage Guidelines

Bison Porcelite

Bison Porcelite is an Alumina Silica resin that when printed and sintered can withstand temperatures up to 1500°C. Bison Porcelite parts are ceramic/polymer composite in the green state. The composite material transforms into a fully functional ceramic material after sintering.

Bison Porcelite has been optimized to work in the Bison 1000 DLP 3D printer. Specific design and sintering parameters need to be followed for optimal results.

Table of Contents

Technical Properties of Bison Porcelite

All of the Technical Properties were done with test parts that we sintered to 1250°C according to the sintering schedule laid out in this document.

Test	Green	Sintered
Shrink Rate at 1250°C	+/- .25 mm deviation	5%
Flexural Strength	Coming Soon	Coming Soon
Vickers Hardness	Coming Soon	Coming Soon
Porosity SEM	Coming Soon	Coming Soon
Density g/cm^3	Coming Soon	Coming Soon
Water Absorption	Coming Soon	Coming Soon
Compression Test	Coming Soon	Coming Soon
Dielectric	Coming Soon	Coming Soon
Coefficient of Thermal Expansion	Coming Soon	Coming Soon
Resin Viscosity at 30°C	Resin Viscosity at 40°C	Resin Viscosity at 45°C

Material Setup

Tools needed	Pre Print Checklist
• Flush Cutter for support removal • Tethon Printwash • Tethon Replacement Vat Film • Cleaning Station / ultra sonic cleaner • Nitrile Gloves • Cleaning Cloth / Paper Towel • Electric kiln or furnace with vent • Microfiber Cloth • 80 Mesh screen or kitchen strainer to filter resin	1. Confirm vat film in resin tray is clear, has no dents on it, and is taut. Replace if damaged. 2. Zero build plate. 3. Wipe down printer window under resin tray. Make sure it is free from smudges and debris. 4. Check all printer settings to ensure your printing with the correct material, layer thickness, heat settings, motor settings, and brightness. 5. Check to make sure you have enough resin in the resin vat. The vat can hold 3/4 of a liter. More resin is better when printing. The extra resin helps improve resin flow. 6. Start print 7. Bison 1000 Settings: Link

Start-Up

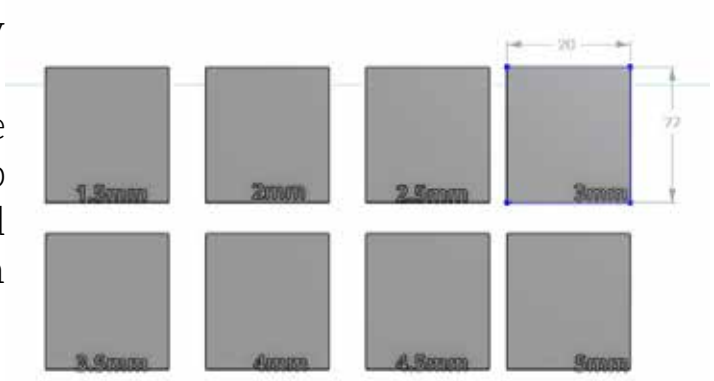
Always start with a clean resin tray. Make sure the Bison 1000 projector window is clean, free from dust and debris. Clean the Bison 1000 with a microfiber cloth.
Make sure the build plate has been zeroed properly. This is often the most important step in setting up your Bison 1000. Please click the link for instruction on how to properly zero our build plate.

https://www.youtube.com/watch?v=_K_YeqA33O4&t=6s

A new vat film is recommended when changing materials. Bison Porcelite can wear out the vat film every 5 - 10 prints depending on geometry.
Filter resin in between prints. New resin directly from the bottle does not need to be filtered. Shake bottle for 30 seconds when using new resin from the bottle. If the print is 100% successful, the resin does not need to be filtered in between prints. Make sure to check the resin tray for any loose print fragments before printing.

Material Calibration

Base Thickness Test +/- .25 mm accuracy



To calibrate the machine, print the Base Thickness file. The most important step is to make sure that the printer is zeroed properly and the resin vat film is clean and not worn out.

[Link to Calibration Files]

If the parts are not sticking to the build plate and the zeroing is done correctly increase the initial exposure time by 5 seconds each time until you see all 8 rectangles stick. If the squares are sticking too much decrease the initial exposure time by 5 seconds incrementally until parts are easy to remove.

If the parts are shorter than the designated measurements on the rectangles then increase the basic exposure time by 5 seconds. If they are too thick then decrease the basic exposure time incrementally by 5 seconds.

If you see the first initial layers stick to the build plate and not the rest of the print then increase the basic exposure time. (See photo number 6 in troubleshooting)

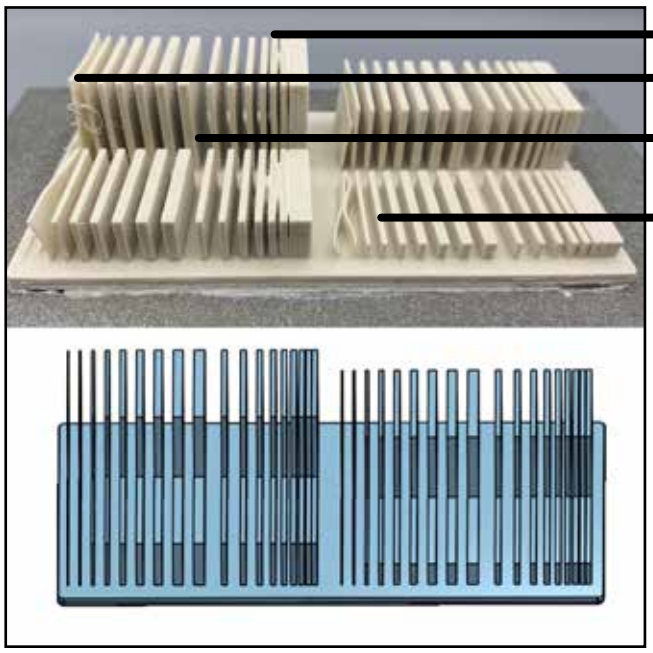
If you have increased the initial exposure time by 30 seconds more than the recommended initial settings, then increase the brightness of the machine by 20 power. Return to original Initial Layer Exposure time after you increase the brightness on the machine.

XY Calibration +/- .25 mm accuracy (xy measurements 20 x 22 mm)

Use the base thickness test and the XY Calibration test files to calibrate the settings on the machine. XY calibration should be done after the base thickness test. You can adjust the **basic exposure** time by intervals of 2 based on if it is larger or smaller than the dimensions. If it is too small, increase the basic exposure time. If it is too big, decrease the basic exposure time. +/- .25mm is within spec.

Design Guidelines for Green Parts

Unsupported Wall Thickness and Wall Spacing



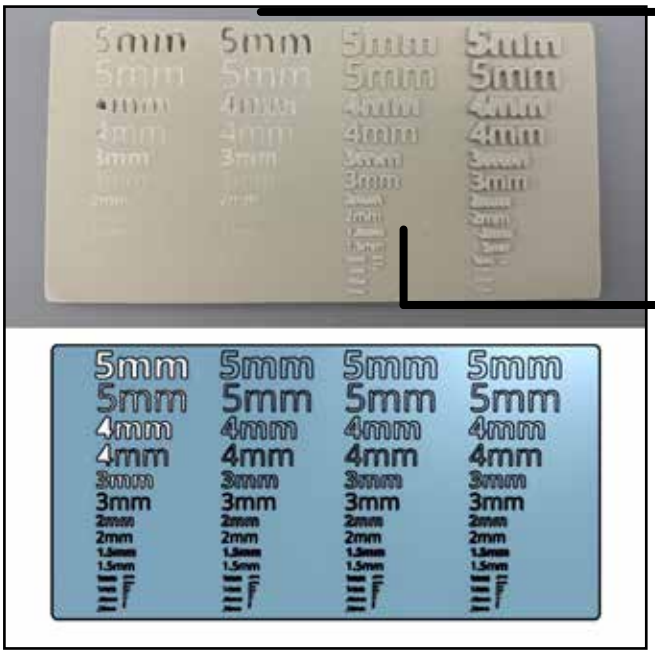
Minimum Wall Spacing: .75mm

Min. Wall thickness w/ max. Wall height: .75mm at 20mm tall

Maximum Wall Thickness: 2mm

Minimum Wall Thickness: .75mm

Text Size - Engraved and Embossed

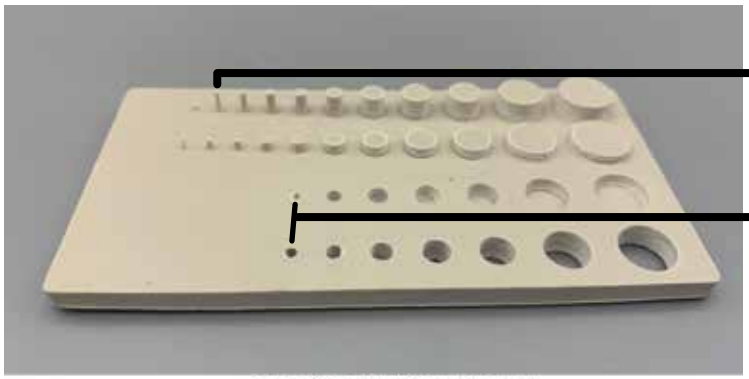


Engraved Text is not recommended for Bison Porcelite.

2mm non bold font recommended for optimum text size.

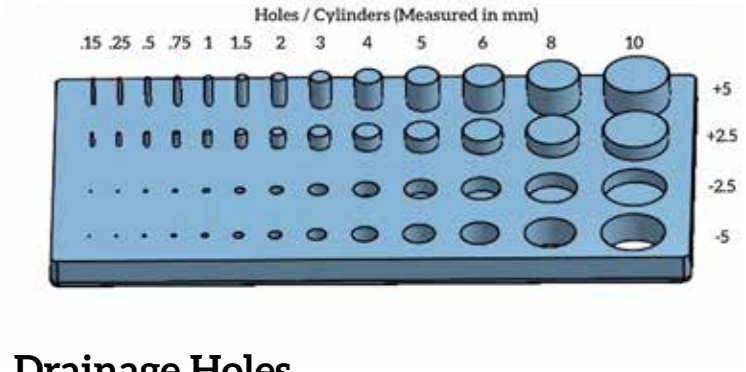
Design Guidelines for Green Parts

Holes and Unsupported Cylinders

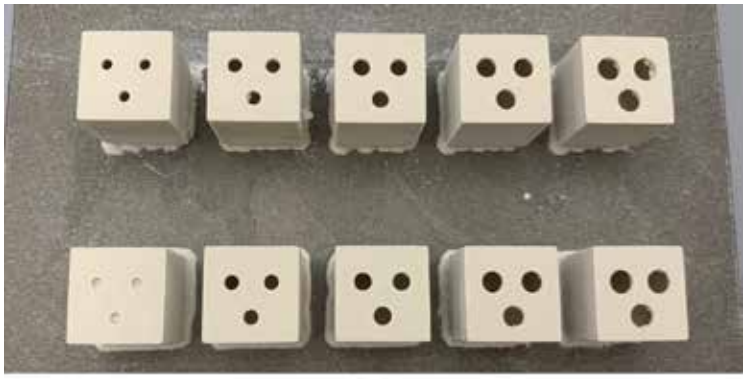


Minimum unsupported post at 5 mm height: .75mm

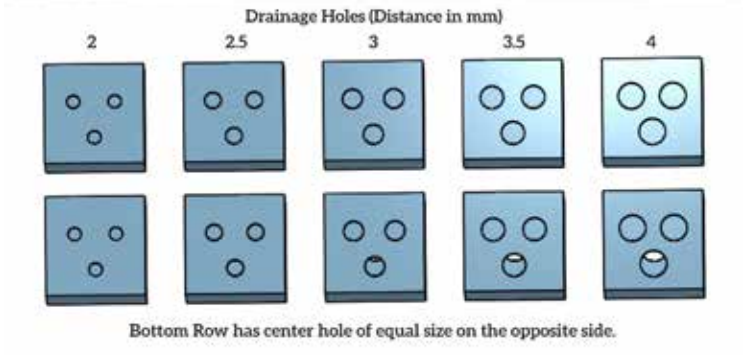
Minimum engraved hole: 2 mm



Drainage Holes

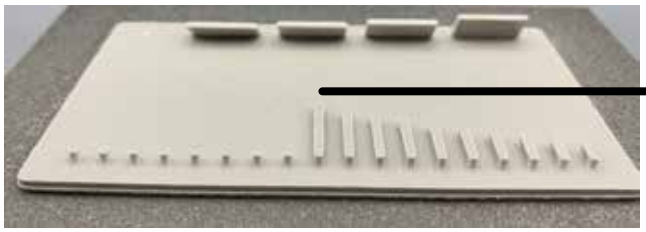


Drainage holes are needed for hollow objects. Three drainage holes are recommended for ease of cleaning. Any excess resin left over in the print can cause part defects in green parts and sintered parts. The leftover resin will add stress to the overall part causing cracks and deformation

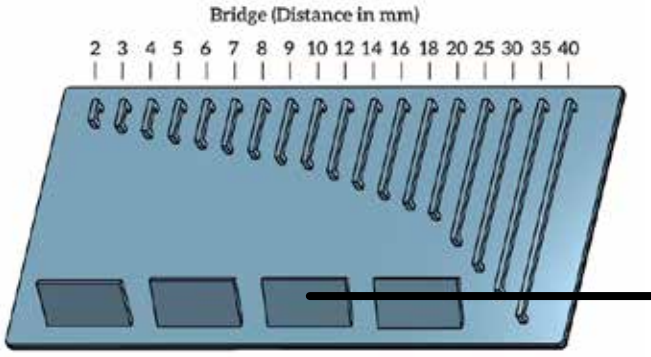


Design Guidelines for Green Parts

Overhang / Bridge Test



Maximum Bridge Distance: 12 mm



Maximum Overhang Angle:

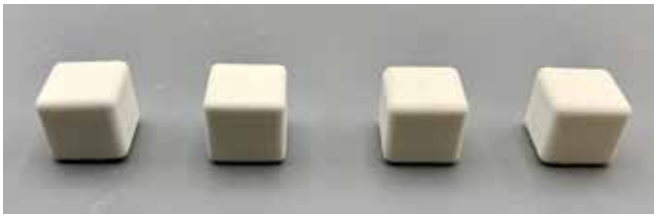
Channel Test

The channel test determines the smallest hollow space that can be printed on a long path. The cylinders are 110 mm long and range from 1 mm in diameter to 5 mm in diameter, maintaining a 1 mm wall thickness

Minimum Diameter Channel: 2mm

Design Guidelines for Sintered Parts

All of the design guidelines for green parts apply to sintered parts. There are some extra design requirements needed for optimized sintering results



1.2mm Fillet

Fillet

Adding a Fillet to any right angle drastically reduces the amount of surface tension in the object. 1 mm to 2.2 mm fillets on any edge will help reduce the amount of cracks formed during sintering. Fillets on interior angles can help add strength and sintering support

Maximum Wall Thickness: 1 cm

Removing Excess Resin

Use drainage holes to allow for uncured resin to be washed out. This is extremely important to not have uncured resin trapped.

Uncured resin shrinks and expands differently than cured resin. This uneven expansion and contraction cracks the object.

Minimum number of drain holes: 4 on opposite ends of the object is best to allow for proper washing. 3 on one side of the object for most of the resin to flow out. One on the opposite side if possible to be able to have print wash flow throughout the object.

Minimum hole diameter : 2mm

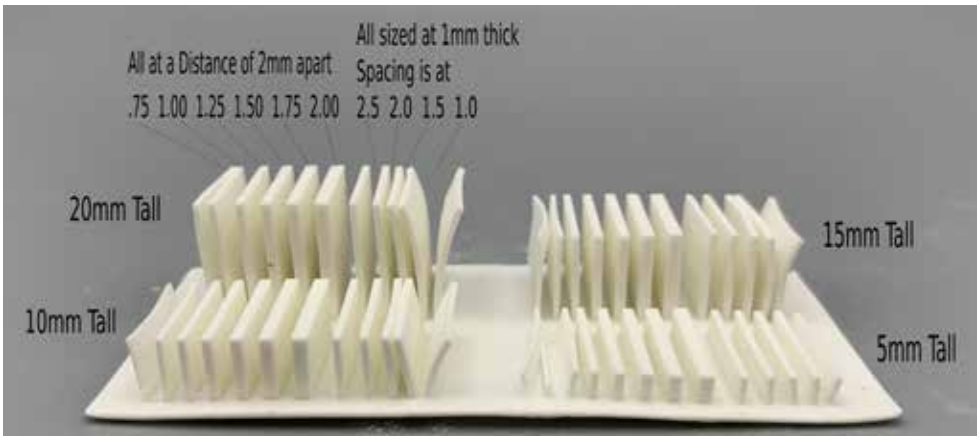
Design Guidelines for Sintered Parts

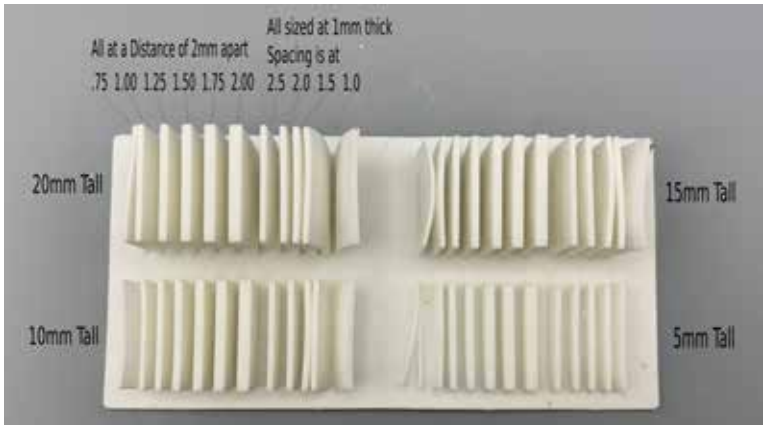
Thread Deviation and Scaling

Ceramic Threads can be made to tolerance with Bison Porcelite. In order to determine the best shrink rate for your threads, scale the nut up 1% over 7 times to determine the appropriate scale for the given geometry. The average scale up is 5%. In the photos below we scaled an M4 nut up 5% uniformly. The bolt threaded well with the nut.

Fully Sintered M4 nut

Wall Thickness and Spacing for Sintering





This test demonstrates the minimum wall thickness for free floating walls. As you can see the walls will move in the furnace if not thick enough or properly supported. Each group of walls are 5mm taller than the last. Some walls work well at a shorter hight. 1 - 1.25 mm wall thickness is recommended for minimum wall support

Design Guidelines for Sintered Parts

Holes and Unsupported Cylinders

Holes do not close completely when sintered at their smallest size. The unsupported cylinder at its smallest size did not warp.

Text Size - Engraved and Em-

Text details remain the same after sintering as they do in the green state.

Overhang / Bridge Test

Bridge Test At 12mm the overhang collapsed. 11 - 1 mm did not sag during sintering.

Overhang Test

Z Direction Shrinkage

The interior of the circle was scaled .5% 5 times past the original amount. This particular geometry needed to be scaled 2.5% more in the z direction than in the x and y.

Some geometries will shrink more in the Vertical or Z direction when sintering. Each geometry can be different. Best way to size a part is scale it up in the Z .5% several times past the average shrink rate.

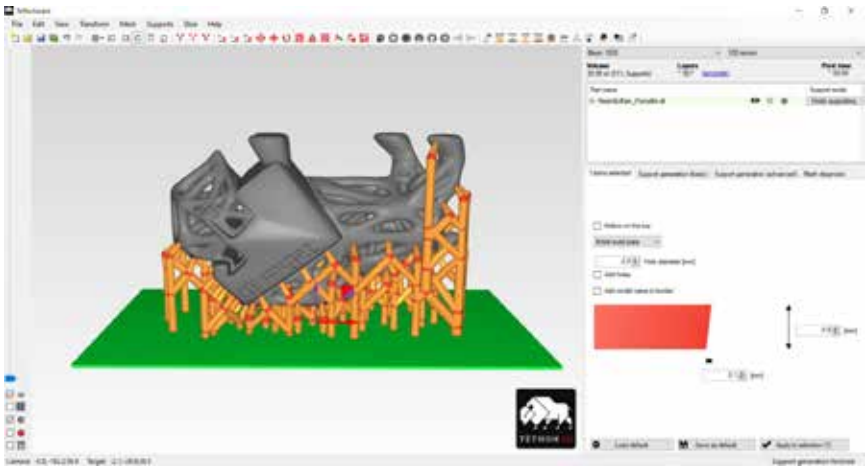
Support Profiles in Tethonware

These settings are to be used as reference points. Each model will require custom settings based on the weight and surface area of the model

Support Settings	Light Supports	Medium Supports	Heavy Supports
Density	80	100	150
Tip Diameter	.5	.7	1.7
Critical Build Angle	45	45	45
Sample Strategy	Creases and Surfaces	Creases and Surfaces	Creases and Surfaces
Surface Sampling	Random	Random	Random
Strategy	Split Style Scaffold-ing	Split Style Scaffold-ing	Split Style Scaffold-ing
Density Main Column	80	90	100
Pole Diameter	1	1.3	1.7
Pole Widening Factor	1.5	2	2.5
Place above base at	4	4	4
Internal Supports Enabled	Use discretion	Use discretion	Use discretion
Height of Foot	.7	.7	.7
Use of absolute foot sizes	Use discretion	Use discretion	Use discretion
Diameter at top of foot	6.0	6.0	6.0
Diameter at bottom of foot	4.0	4.0	4.0
Base Thickness	1	1	1
Add Base Plate	Yes	Yes	Yes

TETHON 3D

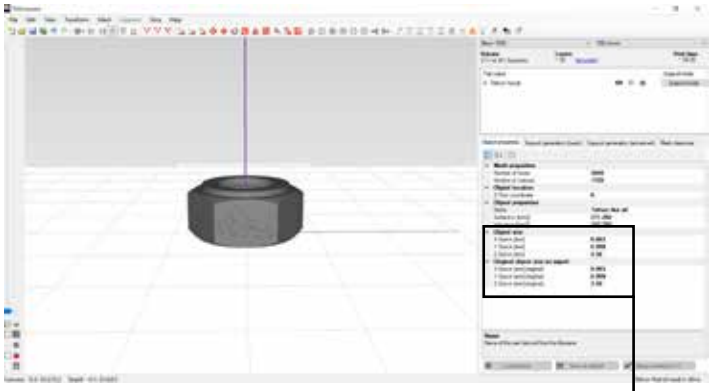
Tethonware Slicer



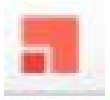
Adding a Base Plate

When printing a larger file it is best to use a base plate to help attach the part to the build plate. Recommended setting for base plate: Deselect - Hollow top and add Add holes. Select entire build plate from the drop down menu.
Adjust the height of the base plate to .8mm and the lip to .1

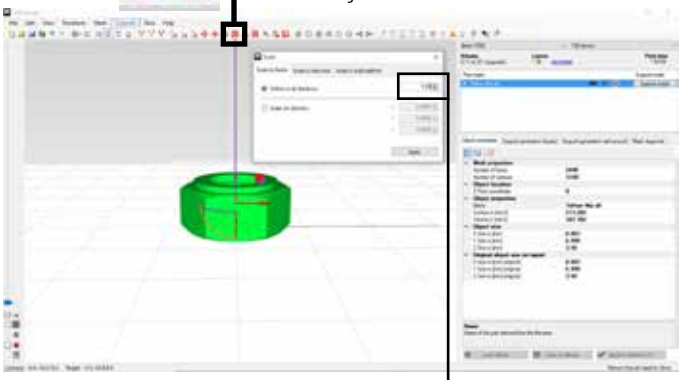
Scaling for Shrinkage



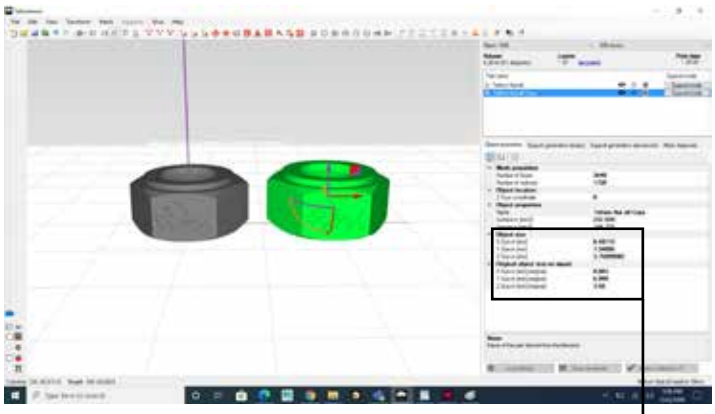
Original scale is shown here on import



Click button to scale object



1.05% for Bison Porcelite



After scaling new dimensions are shown under object size

When sintering Bison Porcelite, scale up the object on average about 5% to account for the shrinkage in the kiln. Most uniform geometries will shrink evenly in the X,Y, and Z direction. If the object is not uniform extra scaling in the z direction maybe required. For optimal scaling for individual parts it is best to print the file without any scaling. Measure the part, then sinter, and measure again after sintering. Use the percent shrinkage in the x,y,z direction to scale up the final object.

Additional Videos on Tethonware

Sintering Instructions

Use a well ventilated kiln. There will be off gassing during the sintering cycle that needs to be vented out of the room. The furnace should have some air flow present during the sintering cycle. A small spy hole in the furnace can be sufficient. A natural draw in the kiln will occur with a small opening in the furnace. If the furnace is airtight and no air is entering the furnace it can cause sintering defects.

Place printed parts in the center of the kiln. This helps ensure even heating. Use of shrink slabs and sintering supports maybe required for some geometries.

The average shrink rate is 5% in the xyz direction printed at 100 micron layers. Non uniform geometry will potentially shrink non uniformly.

Use alumina hydrate like baking flour to help keep your parts from not sticking to the kiln shelf or sintering supports.

Sintering Profile

Celsius

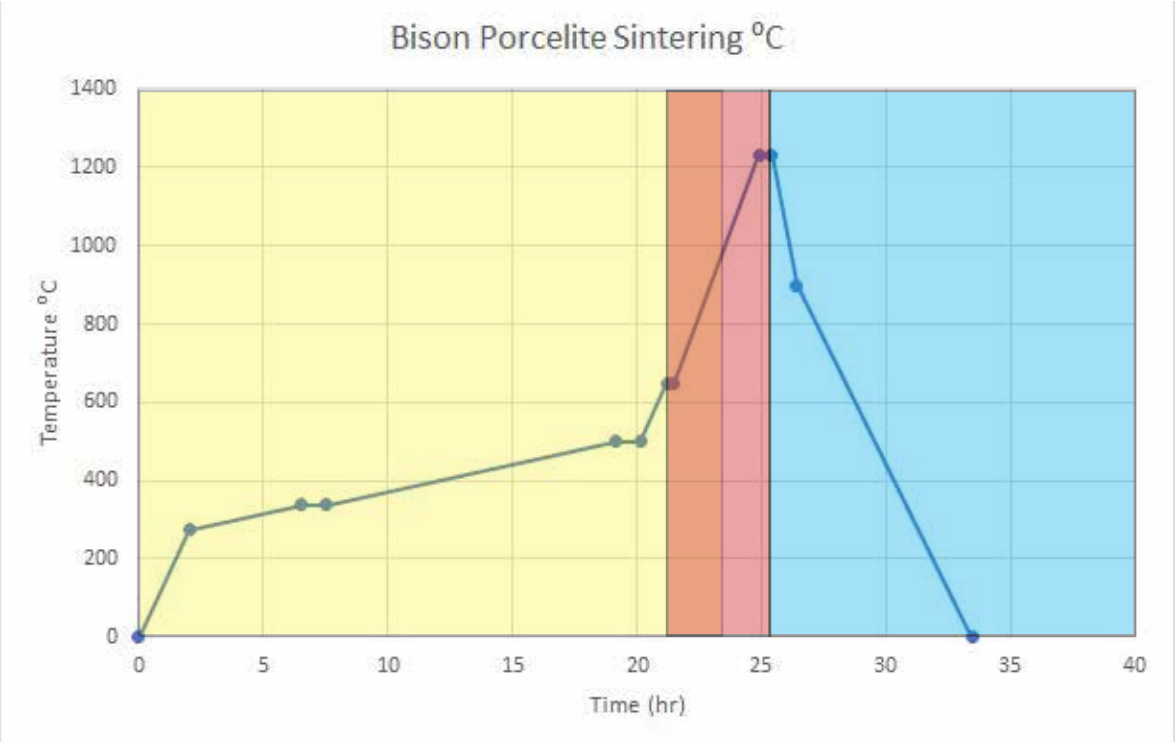
Degree Per Hour	Target Temp	Hold for X Minutes
135°C	275°C	0
14°C	275 - 338°C	60
14°C	338 - 500°C	30
135°C	500 - 650°C	15
170°C	650 - 1300°C	30

Fahrenheit

Degree Per Hour	Target Temp	Hold for X Minutes
258°F	527°F	0
25°F	527 - 640°F	60
25°F	640 - 932 °F	30
258°F	932 - 1200°F	15
275°F	1200-2300°F	30

Sintering Instructions

Sintering chart for Bison Porcelite



Burn out cycle. This section of the sintering cycle has off gassing. Make sure the kiln is properly vented during this section. The burn out section can be done in a separate furnace. The parts are extremely fragile after this section and should not be handled with any force but they could be transported carefully on a kiln shelf to another furnace for final sintering.

Sintering. This section of the sintering cycle transforms the green part into a ceramic part. This section of the cycle can have different ending temperatures based on the desired result. The hotter the temperature (up to 1500°C) the denser the part.

Cooling. The cooling section of the sintering cycle is a natural cool down. No programing is required for normal use. If cooling cracks occur or you are sintering in a cold environment then a controlled cooling may be required. Set the furnace to cool at 400*C per hour to room temp.

Troubleshooting

Printing Problems

Problem	Cause	Solution
1. Nothing sticks to build plate	Only a thin layer is formed in resin tray	Re-zero build plate, replace resin vat film, increase initial exposure
2. Nothing sticks to build plate after all steps are followed for number 1	Brightness is too low	Increase brightness power by 20
3. Part starts to print but falls off after many layers	Part is too heavy or too high of surface area	Increase initial exposure time incrementally by 5 sec.
4. Base plate and supports print, but part falls off supports	Part is too heavy or surface area is too much for supports	Increase support tip size and density of supports and or increase basic exposure time
5. Parts can't bridge gaps without failing	Resin is not curing enough to form a strong bridge	Increase basic exposure time to help increase bridging
6. Parts only stick for first few layers. Supports do not start printing	Resin is not fully curing	Increase basic exposure time
7. Parts were sticking just fine then they stop sticking	Resin vat film is wearing out	Replace vat film
8. Parts stop printing evenly across the build plate	Machine error or debris in resin	Restart machine and filter resin
9. Center section of print does not print	Resin is not flowing into the center of the resin tray	Increase the motor moving distance, increase the layer wait time
10. Parts are becoming blurry or have overgrown resin on them	Window or projector have dust on them	Clean window with micro fiber cloth. If this does not solve the issue contact support about how to clean projector
11. Overgrowth or ragging occurring on sides of prints. Prints are not smooth	Resin is over curing beyond the border of the print	Reduce basic exposure time by 5 seconds incrementally. Reduce brightness if available by 20.
12. Parts are larger on one side than the other / uneven	Build plate moving too fast causing extra force	Slow down motor speed to 1 or 2 to reduce drag force

Troubleshooting

Printing Problems Continued

Problem	Cause	Solution
13. Printer squeaks when lifting in between layers	Motor is being strained	If parts are stuck to the build plate and hard to remove decrease initial exposure time. Otherwise this sound is normal
14. Smaller part prints well, when switching to a larger part it falls off the build plate	Not all settings are the same for large and small parts	Refer to the link for settings for larger parts. Settings Link
15. Part of the print sticks to build plate half does not.	Resin tray is wearing out	Replace vat film, and re-zero build plate
16. Printed part has a section separating- a line of separation across the entire print.	The resin is curing at the minimum amount / barely curing	Increase basic exposure time by 5 seconds. Restart machine if problem continues.
17. Parts are hard to remove from build plate	Over curing to build plate	Reduce initial exposure time by 5 seconds incrementally until it is easy to remove
18. The part shows print striations, vertical lines that go against the layers formed during printing.	Resin tray film is wearing out	Replace resin tray film. Re-zero printer
19. Voids or pits are forming on the print	Build plate or resin tray is wearing out	Replace resin tray film or build plate.
20. Parts not bridging after basic exposure increase	Machine Projector not bright enough	Increase brightness by 20
21. Larger parts are not sticking to build plate after increasing the initial exposure time 50 seconds	Projector does not have enough power	Increase brightness of light engine by 20 - 50 more.

Troubleshooting

Sintering Problems

Problem	Cause	Solution
A. Cracks in Sintering	1. Trapped Resin	Uncured resin is trapped inside the part. Properly drain and remove all excess uncured resin.
B. Cracks in Sintering	2. No Fillet	Right angles are prone to start cracks. Using a fillet edge (1.2 mm recommended) reduces the surface tension on the piece
C. Cracks in Sintering	3. Slow Sintering	Sintering with too slow of a ramp or hold can cause part deformation. Increase ramp speed and decrease hold time
D. Cracks in Sintering	4. Non Uniform Sintering temperature	If your elements are worn out, one side of the furnace may heat less than the other. Replace elements
E. Cracks in Sintering	5. Non Uniform Shrinkage	5. If you do not have a uniform thickness throughout the part or if there is more weight on top than on bottom make sure the weight of the object is down when sintering.
F. Bottom is wider than the top	Part could not move freely on kiln shelf during sintering	Place alumina hydrate on the surface of the kiln shelf to reduce tension while sintering. Use a shrink slab to help shrink the object in the right direction.
G. Object is non uniformly / warped	Wall thickness and support structure are not large enough	Add internal supports and fillets to help strengthen the part during sintering. Using an appropriate wall thickness relative to the part.
H. Glaze melts part	Add slip layer under glaze.	Add layer of slip under the glaze. Sinter the slip once before adding glaze over slip.

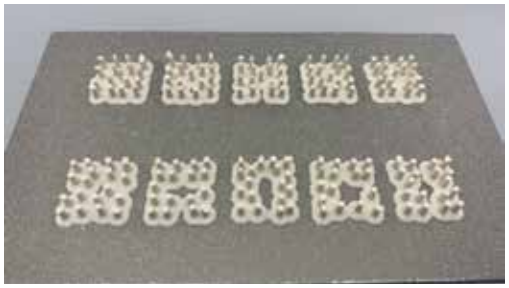
Troubleshooting

Photo Examples

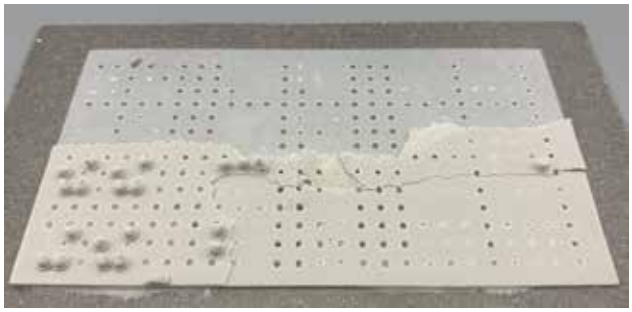
Printing Problems

1.

4.



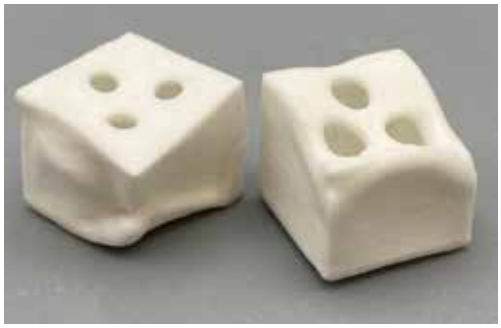
6.



Sintering Problems

A.

H.



Contact

Email: support@tethon3d.com

Phone: 402-281-4085

Website: Tethon3d.com