

1- Zetamix General guidelines Black Zirconia

Zetamix filaments are on a fine powder ($< 1.0 \mu\text{m}$) and a thermoplastic binder system for the FDM process. Green parts need a binder removal in a two-stage debinding process before being sintered. First debinding step is dissolving the binder in a solvent bath. In the second debinding step the remaining binder is thermally removed. These general guidelines are based on the processing of test parts with a wall thickness of 2 mm.

The recommendations are considered to work as a standard guideline and must be adapted to individual wall-thickness and part-design.

Filament characteristics

Typical material properties	
<i>Product</i>	Filament for FDM process
<i>Binder basis</i>	Polyolefinebased binder system
<i>Appearance</i>	Black filament

Typical processing properties	
<i>Printing temperature</i>	170 °C
<i>Plate temperature</i>	50 °C
<i>Nozzle size</i>	From 0.4 mm to 1 mm (need to adjust the printing speed, the wider the nozzle the slower) 0.6mm recommended
<i>Layer thickness</i>	0.15mm (possibility to go from 0.1 to 1mm, need to adjust printing speed)
<i>Printing speed</i>	20mm/s - 35mm/s
<i>Debinding process</i>	Two-stage debinding process
<i>1st step : chemical debinding</i>	2 hours in a acetone bath at 40°C 2 hours drying in ambient atmosphere
<i>2nd step : thermal debinding</i>	Thermal debinding up to 500 °C with a 8°C/h ramp
<i>Sintering</i>	20°C to 1475°C with a 50°C/hour ramp 2 hour holding time
<i>Shrinkage rate</i>	21.5% (x and y) / 21.1% (z)

Printing instructions:

It is preferable to use a driving gear which is not too much aggressive and will not crush the filament (ideally a grooved driving gear). The filament can be grinded by the extruder, that's why it should be cleaned before a long print. To make sure that the printer is ready we recommend preheating the system and start extruding some material. If nothing comes out of the nozzle there might be a clog. Therefore, the nozzle must be replaced or cleaned.

We recommend the use of a wear resistant nozzle, for instance with a ruby or ceramic tip. We recommend printing the piece on a glass plate in order to obtain a good surface quality. The part can be detached from the build plate using an ultrasound bath.

Printing parameters: Refers to the IdeaMaker parameters guidelines

Scale: 127.4 % (x and y) / 126.8% (z)

Printing speed: from 20 to 35 mm/s depending on the shape of the part

Layer height: from 0.3mm down to 0.1mm

Retraction: 1mm at 20 mm/s

Fan speed: 100% (the higher the better the print quality)

Wall line count: at least two

Infill: any 2D pattern (triangles, grid, honeycomb, rectilinear)

Infill density: from 100% down to 5% (the top surfaces above the infill depends on the pattern infill density)

Top/bottom surface number:

- for a 0.1mm layer height: 10
- for a 0.2mm layer height: 5

Supports structure: Can be printed using the same material or a soluble material via a dual extrusion system. In order to have a great surface quality at least 3 dense top layers should be printed between the support structure and the part.

2- Debinding Recommendations

First step: solvent debinding (acetone bath)

Step 1: Solvent bath

- It is recommended to debind the printed parts in an acetone bath at 40 °C.
- At least 5% of the weight of the piece should be removed during the solvent debinding step (after drying).
- The duration is depending on wall thickness and part geometry but takes at least 2 hours.

Step 2: Drying

- Let the parts dry at the ambient air (the part can be placed on a tissue to absorb the water)
- The duration is depending on wall thickness and part geometry but takes at least 2 hours.
- This step is essential to measure the mass removed by the solvent debinding step

Second step: thermal debinding

Place the parts in a crucible on a refractory powder bed to accommodate shrinkage and support the part during debinding.

The most reliable process consists of a heating rate of 8°C per hour from 20°C to 500°C. It takes 2 and a half days to complete the debinding.

For small parts the process can be as described below:

segment	From (°C)	To (°C)	Heating rate (°C/h)	Dwell time (h)	Segment duration (min)	Duration in total (h)
0		20			0	0
1	20	125	35		180	3h
2	125	200	50		90	4h30
3	200	215	22		40	5h10
4	215	250	11		180	8h10
5	250	280	20		90	9h40
6	280	320	8		300	14h40
7	320	510	24		480	22h40

3- Sintering Recommendations

Sintering in a high temperature furnace

Thermal cycle: 20 - > 1475°C with 50°C/h ramp, in 29h
holding time 2h
1475 - > 20°C with 100°C/h ramp, in 15h

Because of the shrinkage, there is a change of volume. Please modify the scale in the slicer before printing, as it is said in "Printing parameters".