1- Zetamix General guidelines silicon carbide

Zetamix filaments are on a fine powder (< 1.0 µm) 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	
Product	Filament for FDM process
Binder basis	Polyolefinebased binder system
Appearance	grey filament

Typical processing properties	
Printing temperature	120°C
Plate temperature	50 °C
Nozzle size	From 0.4 mm to 1 mm (need to ajust the printing speed, the wider the nozzle the slower) 0.6mm recommended
Layer thickness	0.20mm (possibility to go from 0.1 to 1mm, need to ajust printing speed)
Printing speed	15mm/s - 30 mm/s
Debinding process	Two-stage debinding process
1st step : chemical debinbing	24 hours in an acetone bath at 40°C (it depends on the geometry of the part) → Mass loss > 12% 2 hours drying in ambient atmosphere
2nd step : thermal debinding	Thermal debinding up to 700 °C with a 10°C/h ramp, 1 hour holding time, all achieved under under primary vacuum
Sintering	20°C to 2200°C with a up to 300°C/hour ramp, 1 hour holding time, all achieved under argon (90 mb)
Shrinkage rate	x,y = 16.8% ±1% z = 22.6% ±1%

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: 120,2 % (x and y) / 129,2% (z)
Printing speed: from 15 to 30 mm/s depending on the shape of the part
Layer height: from 0.3mm down to 0.1mm
Retraction: 1mm at 5 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 12% 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 10°C per hour from 20°C to 700°C. It takes 3 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	RT	700	10	1	4200	70
1	700	RT	50		840	84

3- Sintering Recommendations

Sintering in a high temperature furnace

Thermal cycle: RT -> 150°C with 100°C/h ramp, under secondary vacuum, in 1 hours and 30 minutes

150°C -> 2200°C with up to 300°C/h ramp, 1 hour holding time, under partial vacuum (90 mb argon) in 8 hours and 20 minutes

2200°C -> RT at maximum 300 °C/h ramp, return to secondary vacuum under 1000°C, in 7 hours and 20 minutes.

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”.

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