Handbook

3D Printing Guide

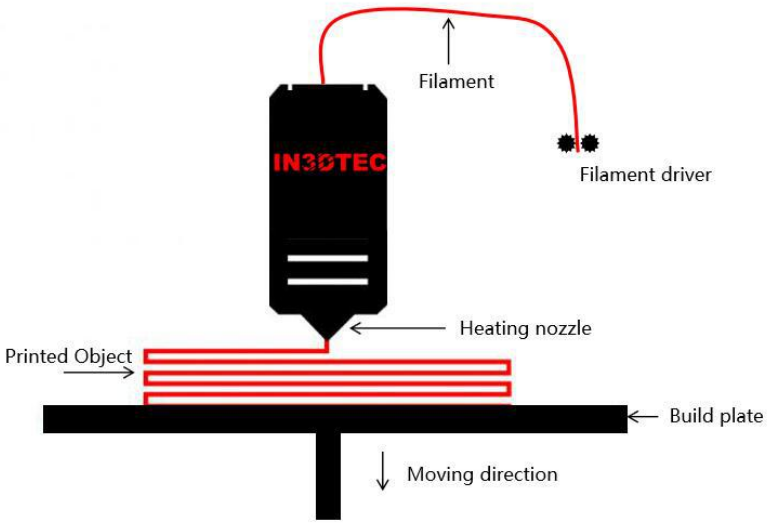
For beginners and professionals

IN3DTEC V6.2.1

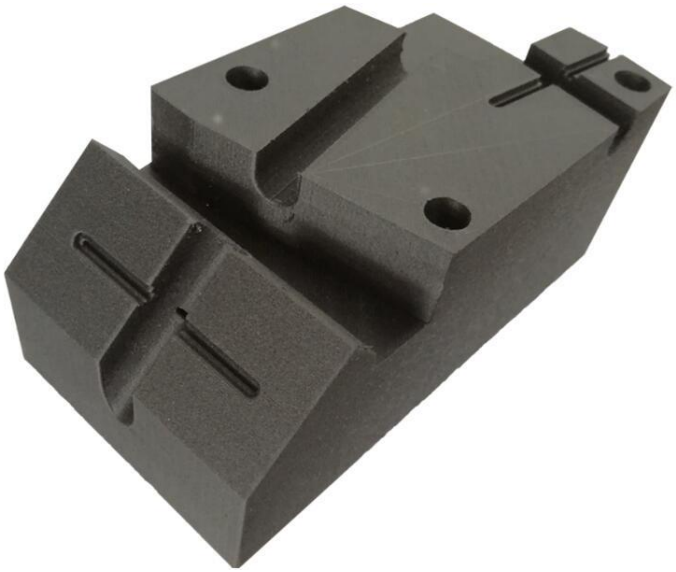
Contents

1 >> Overview of 3d printing technologies

1.1 Fused deposition modeling (FDM)

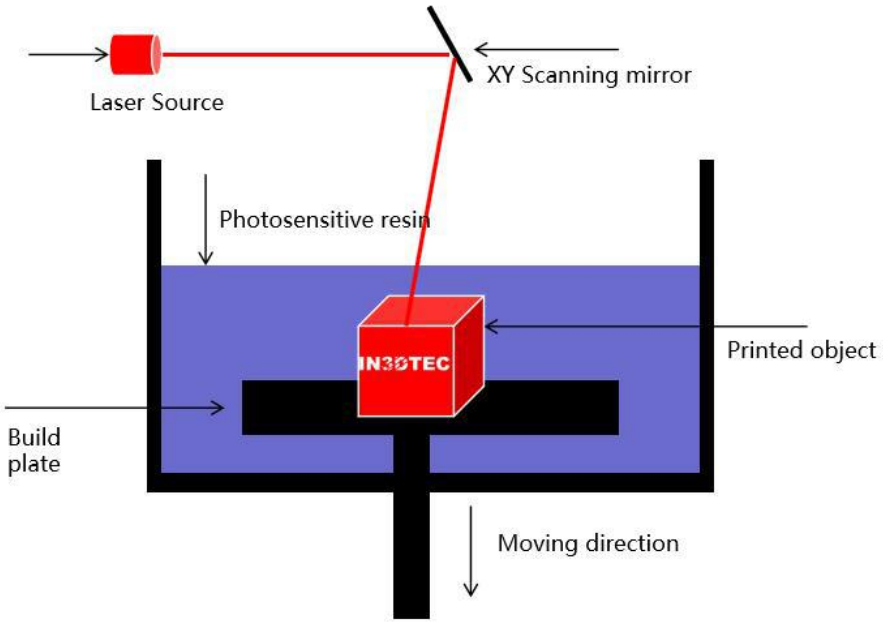


The FDM process uses a digital design (Gcode) that is uploaded to the 3D printer. The filaments are melted and fed onto the build plate, as the nozzle moves across the plate, the plastic cools and becomes solid, forming a hard bond with the previous layer, layer by layer until the object is finished.



Jigs & fixtures
PA + Carbon fiber
FDM

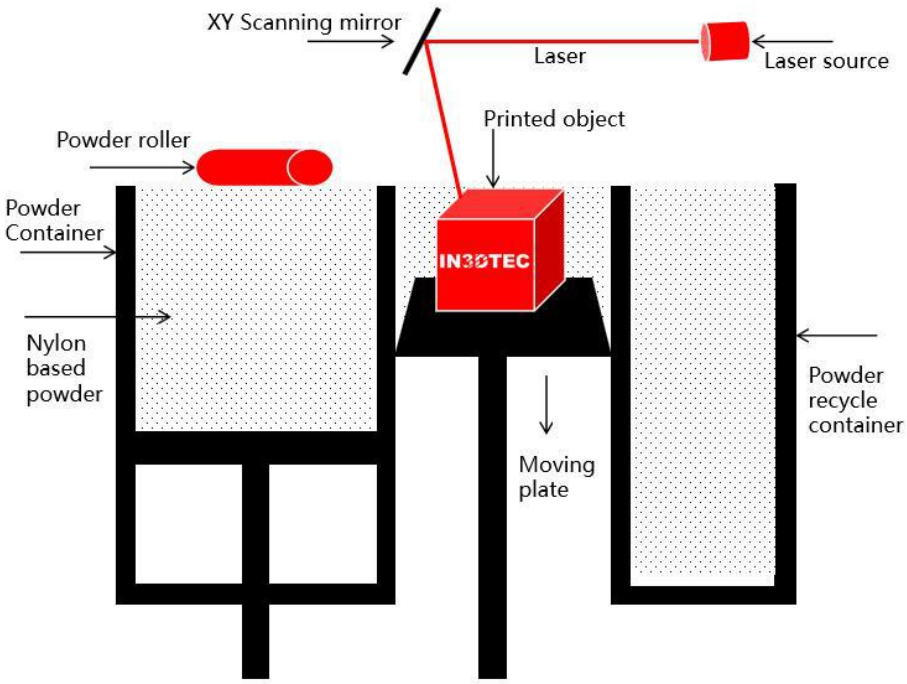
1.2 Stereolithography (SLA)



The SLA 3D Printers begin drawing the layers of the support structures, followed by the object itself, with an ultraviolet laser aimed onto the surface of a liquid photo-polymer resin. After a layer is imaged on the resin surface, the build platform shifts down and a re-coating bar moves across the platform to apply the next layer of resin. The process is repeated layer by layer until the object is complete.

Valve
Clear resin
SLA

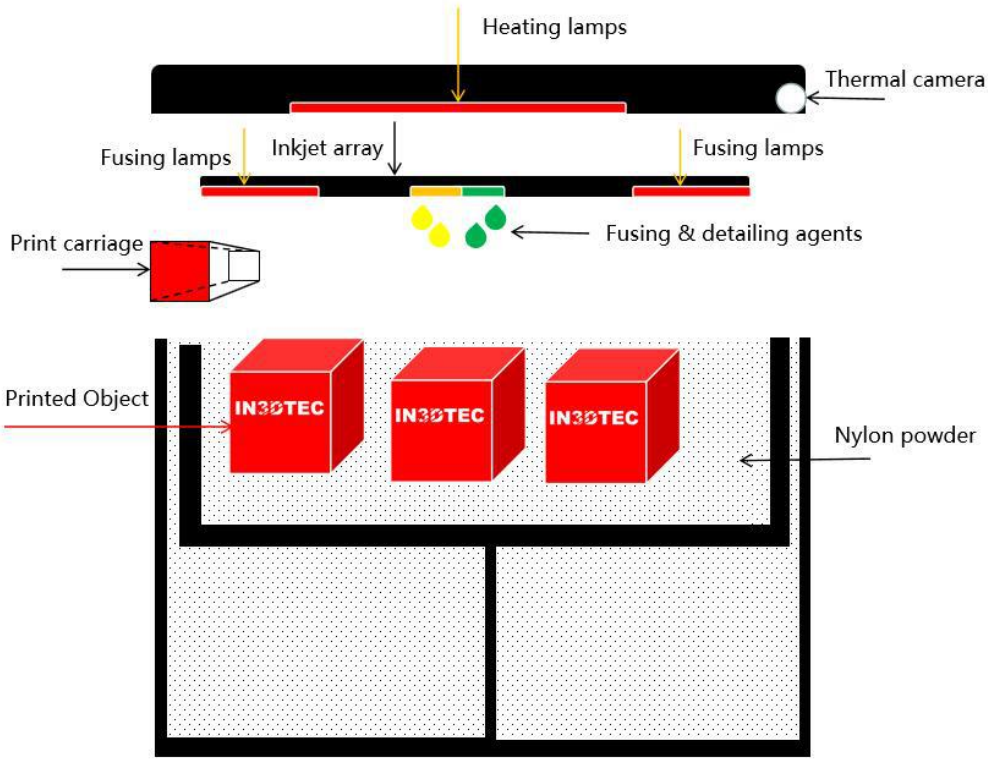
1.3 Selective Laser Sintering (SLS)



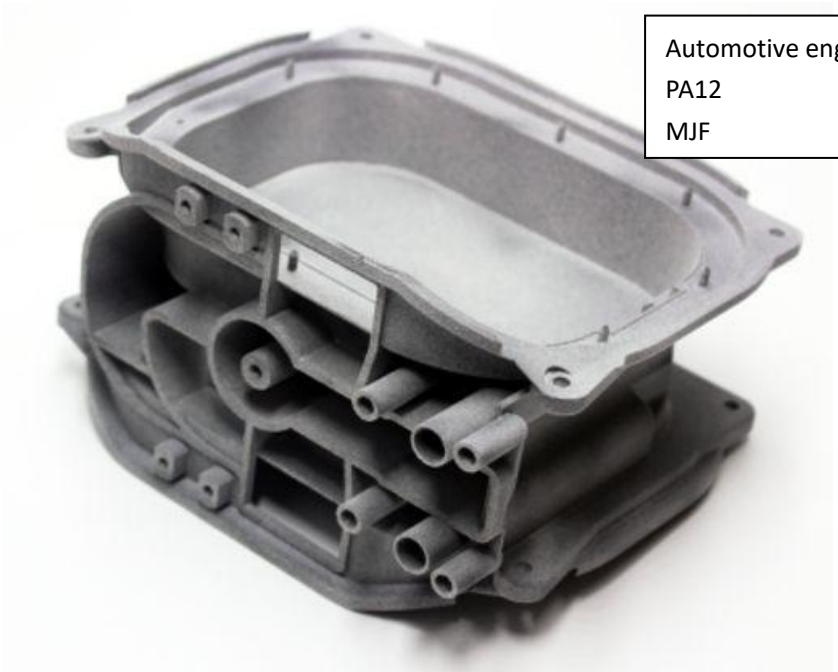
The SLS machine begins sintering each layer of part geometry into a heated bed of nylon-based powder. After each layer is fused, a roller moves across the bed to distribute the next layer of powder. The process is repeated layer by layer until the build is complete.

Bike stopwatch holder
PA12, PA12+GB
SLS

1.4 Multi Jet Fusion (MJF)

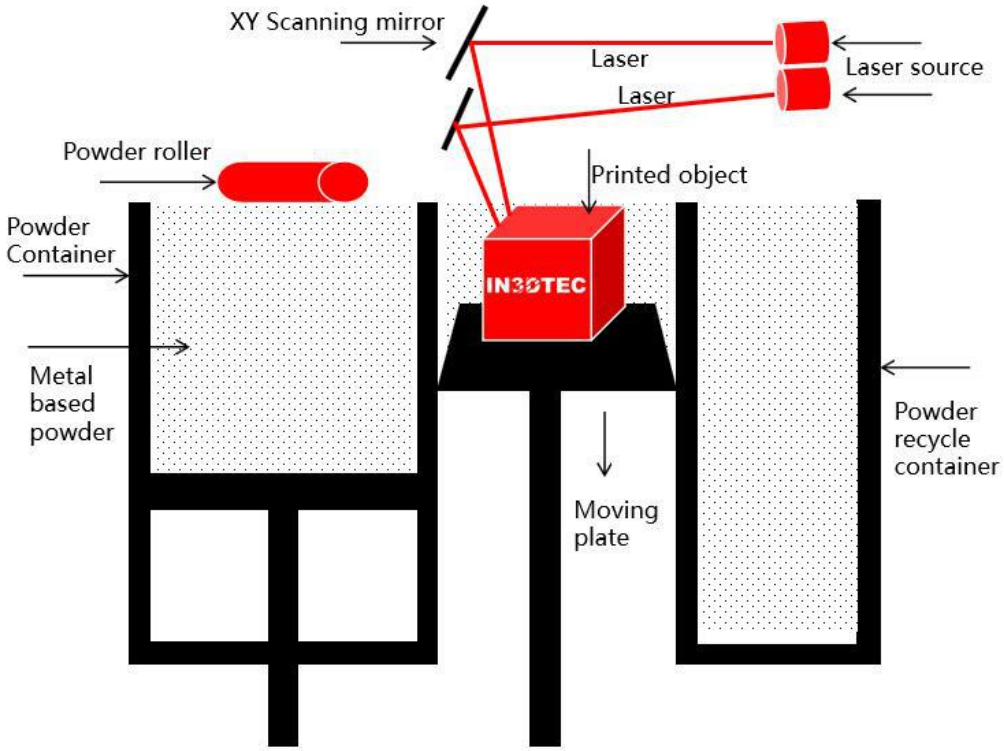


Multi Jet Fusion uses an inkjet array to selectively apply fusing and detailing agents across a bed of nylon powder, which are then fused by heating elements into a solid layer. After each layer, powder is distributed on top of the bed and the process repeats until the parts is complete.

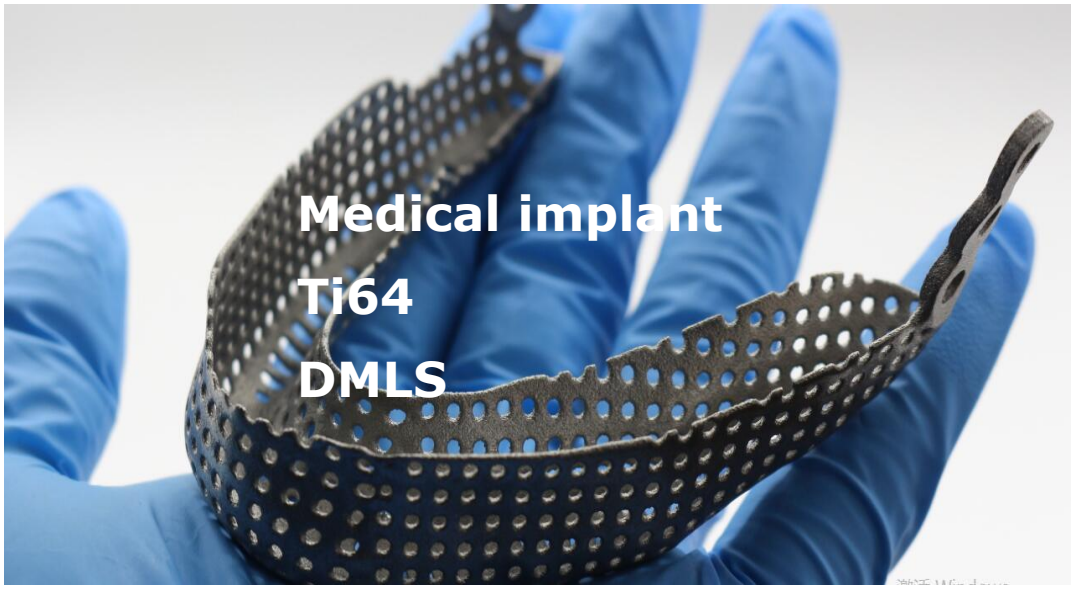


Automotive engine
PA12
MJF

1.5 Direct Metal Laser Sintering (DMLS, SLM)

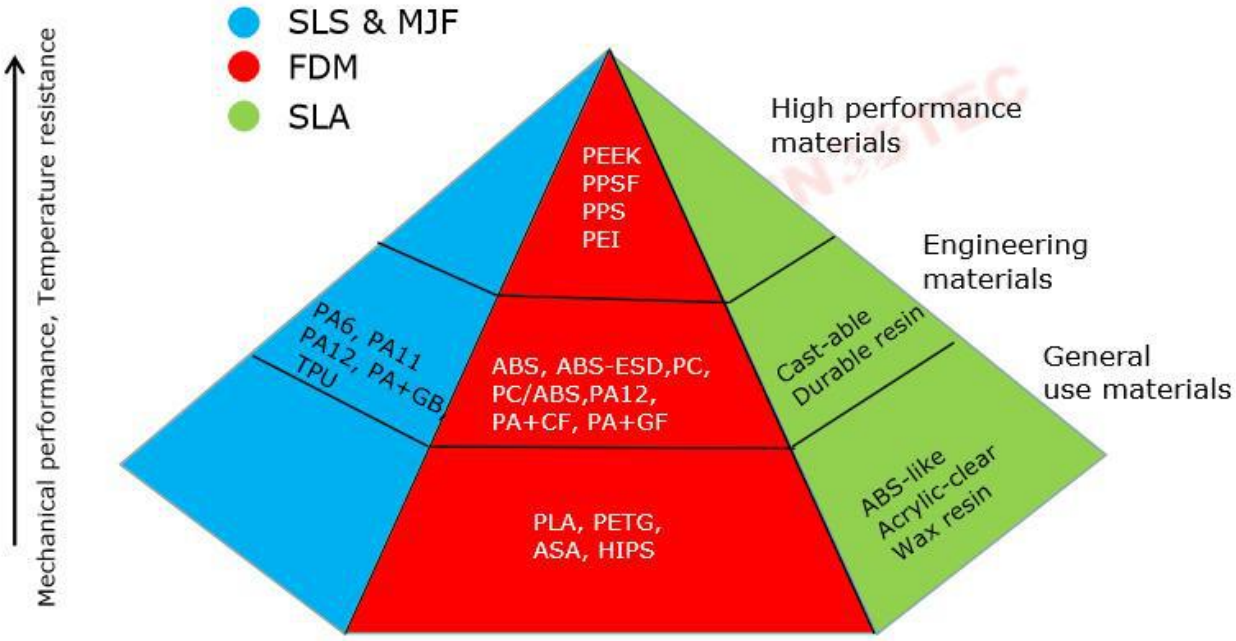


The DMLS machine begins sintering each layer-first the support structures to the base plate, then the part itself, with a laser aimed onto a bed of metallic powder. After a cross-section layer or powder is micro-welded, the build plate shifts down and a recoater blade moves across the platform to deposit the next layer of powder into an inert build chamber. The process is repeated layer by layer until the part is complete.



2 >> Overview of 3D Printing materials & material data sheets

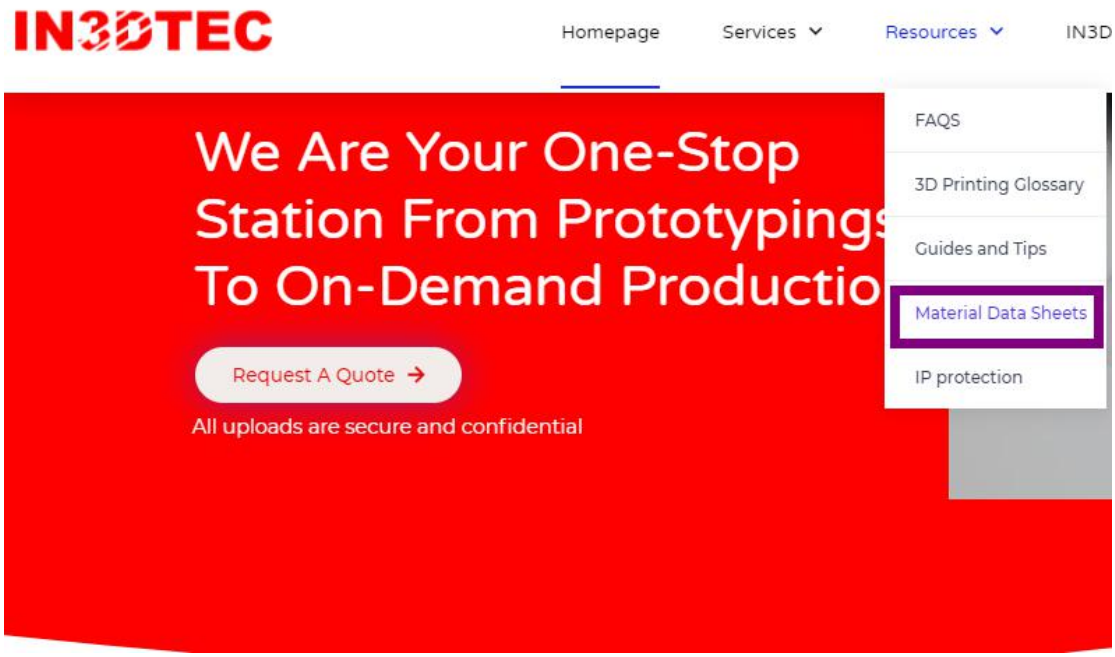
2.1 3D printing materials



Parameter	FDM	SLA	SLS	MJF	SLM/DMLS
Printing principle	Extrusion of melted filament	UV curing	Laser Sintering	Inkjet to selectively apply fusing and agents	Laser Melting
Layer height	50-200μm	25-50μm	32-50μm	50-100μm	50-100μm
Supported Materials	PLA, ABS, ASA, PC, PC/ABS,PC, PA+CF, PPSF, PEI, PEEK	ABS, Clear resin, Durable resin, Wax, Cast-able resin	PA12, PA12+GF, TPU	PA11, PA12, PA+GF	Aluminum, Stainless steel, Ti64, 18Ni300
Minimum Wall thickness	1.0mm	0.5mm	0.8mm	0.8mm	0.8mm
Achievable quality	Visible lines on the surface	Very smooth	Smooth	Smooth	Smooth

Please click HERE to view the materials data-sheets

Or visit our website to get it.



2.2 Mechanical & chemical resistance

FDM Materials-1

Properties	ABS	ASA	PETG	PC	PC/ABS
Young's modulus (MPa)	2147	2379	1523	2048	1832
Tensile strength (MPa)	33.6	43.8	31.8	62.7	39.9
Elongation at break (%)	2.7	6.8	4.4	12.2	4.2
Bending modulus (MPa)	1400	3208	N/A	2045	2081
Bending strength (MPa)	59	73.1	55.1	94.1	66.3
Charpy impact strength (kJ/m2)	12.6	27.5	2.4	25.1	25.8
Aceton	dissolve	dissolve	Serious impact	Serious impact	Serious impact
Water absorption, Equilibrium, 23°C	No impact	No impact	No impact	No impact	No impact
Sodium Hypochlorite 15% (Chlorine Bleach)	Slight impact	N/A	N/A	No impact	No impact
Oil	Slight impact	N/A	N/A	No impact	No impact
Alcohol, Aliphatic	N/A	No impact	No impact	Slight impact	No impact
Weathering resistance	Slight impact	No impact	N/A	No impact	Slight impact
Hot water	Serious impact	Slight Impact	Slight impact	Slight impact	Slight impact

FDM Materials-2

Properties	PA+CF	PEI 1010	PEI 9085	PPSF	PEEK
Young's modulus (MPa)	7453	2750	2500	2100	3738
Tensile strength (MPa)	105	68	65	55	98
Elongation at break (%)	3	3.3	5.8	3	9.1
Bending modulus (MPa)	8339	3197	2550	2200	3612
Bending strength (MPa)	169	120	110	110	147
Charpy impact strength (kJ/m2)	13.4	30	N/A	N/A	N/A
Acetone	No impact	Serious impact	Serious impact	N/A	No impact
Water absorption, Equilibrium, 23°C	No impact	No impact	No impact	No impact	No impact
Sodium Hypochlorite 15% (Chlorine Bleach)	No impact	No impact	No impact	No impact	No impact
Oil	No impact	No impact	No impact	No impact	No impact
Alcohol, Aliphatic	No impact	No impact	No impact	No impact	No impact
Weathering resistance	No impact	No impact	No impact	No impact	No impact
Hot water	Slight impact	No impact	No impact	No impact	No impact

SLA Materials

Properties	ABS-like	Acrylic-Clear Resin	Somos-Tauru s	Somos-128	Somos-800 0
Young's modulus (MPa)	2500	2860	2310	2946	2370
Tensile strength (MPa)	40	55	46.9	56.8	47.2
Elongation at break (%)	4	4	4	11	8
Bending modulus (MPa)	2300	2410	2054	2654	2222
Bending strength (MPa)	70	82	73.8	80	66.8
Charpy impact strength (kJ/m2)	10.5	10.5	47.5	38.9	23
Acetone	Serious impact	Serious impact	Serious impact	Serious impact	Serious impact
Water absorption, Equilibrium, 23°C	Slight impact	Slight impact	Slight impact	Slight impact	Slight impact
Sodium Hypochlorite 15% (Chlorine Bleach)	Serious impact	Serious impact	Serious impact	Serious impact	Serious impact
Oil	Serious impact	Serious impact	Serious impact	Serious impact	Serious impact
Alcohol, Aliphatic	Serious impact	Serious impact	Serious impact	Serious impact	Serious impact
Weathering resistance	Serious impact	Serious impact	Serious impact	Serious impact	Serious impact
Recommended Max. use temperature	35°C	35°C	45°C	45°C	45°C

SLS materials

Properties	PA6	PA12	TPU	PA+GB
Young's modulus (MPa)	3200	1650	61	3200
Tensile strength (MPa)	74	48	18	51
Elongation at break (%)	4	4	276	9
Bending modulus (MPa)	2300	1500	86	2900
Bending strength (MPa)	99	N/A	6.2	70
Charpy impact strength (kJ/m2)	10.5	53	No break	35
Acetone	No impact	No impact	No impact	No impact
Water absorption, Equilibrium, 23°C	No impact	No impact	Slight impact	No impact
Sodium Hypochlorite 15% (Chlorine Bleach)	N/A	No impact	No impact	No impact
Oil	Slight impact	No impact	Slight impact	No impact
Alcohol, Aliphatic	N/A	No impact	No impact	No impact
Weathering resistance	No impact	No impact	N/A	No impact
Hot water	Slight impact	Slight Impact	Slight impact	Slight impact

MJF Materials

Properties	PA11	PA12	PA+GF
Young's modulus (MPa)	1800	1800	2500
Tensile strength (MPa)	52	48	30
Elongation at break (%)	60	20	10
Bending modulus (MPa)	1700	1800	2700
Bending strength (MPa)	65	70	65
Charpy impact strength (kJ/m2)	N/A	N/A	N/A
Acetone	No impact	No impact	No impact
Water absorption, Equilibrium, 23°C	No impact	No impact	No impact
Sodium Hypochlorite 15% (Chlorine Bleach)	No impact	No impact	No impact
Oil	No impact	No impact	No impact
Alcohol, Aliphatic	No impact	No impact	No impact
Weathering resistance	No impact	No impact	No impact
Hot water	Slight impact	Slight impact	Slight impact

For Metal printed materials, please contact our team directly.

2.3 Available surface finishes

Technology	Initial colors	Polish & Coloring	Coloring
FDM	Multiple colors	Sand-blasting, Sand-paper polish	Spray Painting, Plating
SLS	White	Sand-blasting	Dyeing & Spray Painting
SLA	White, Clear,	Sand-paper polish	Spray painting, Plating
MJF	Grey, Black	Sand-blasting	Dyeing & Spray Painting
SLM, DMLS	Metal color	Sand-blasting, Electropolishing	Anodizing, Spray Painting, Plating

2.4 Tolerance and roughness

Technology	Tolerancing (mm)	Smoothness/Roughness
FDM	Length within 100mm +/- 0,25mm; length >100mm, 100*0.25%mm	Visible lines on the surface, Ra24
SLS	Length within 100mm +/- 0,2mm; length >100mm, 100*0.2%mm	Smooth, Ra7
SLA	Length within 100mm +/- 0,1mm; length >100mm, 100*0.1%mm	Very smooth, Ra4.5
MJF	Length within 100mm +/- 0,2mm; length >100mm, 100*0.2%mm	Smooth, Ra7
SLM, DMLS	Length within 100mm +/- 0,1mm; length >100mm, 100*0.1%mm	Smooth, Ra7

2.5 Functional materials

High temperature resistance:

PEEK+CF(280℃), PEEK(260℃), PEI(180℃), PPSF(180℃), PA+GF(FDM, SLS, MJF)

Medical grade Materials:

ABS M30i(FDM), PEEK(FDM), PPSF(FDM), PA12(SLS & MJF), PA11(MJF), Ti64(SLM)

ESD Material:

ESD-ABS

Flame retardant materials:

PC-FR(FDM), ULTEM 1010 & 9085(FDM), PEEK(FDM), PA12-FR(SLS), PPS(FDM)

Waterproof materials:

PETG(FDM), PC(FDM), PEEK(FDM), PA12

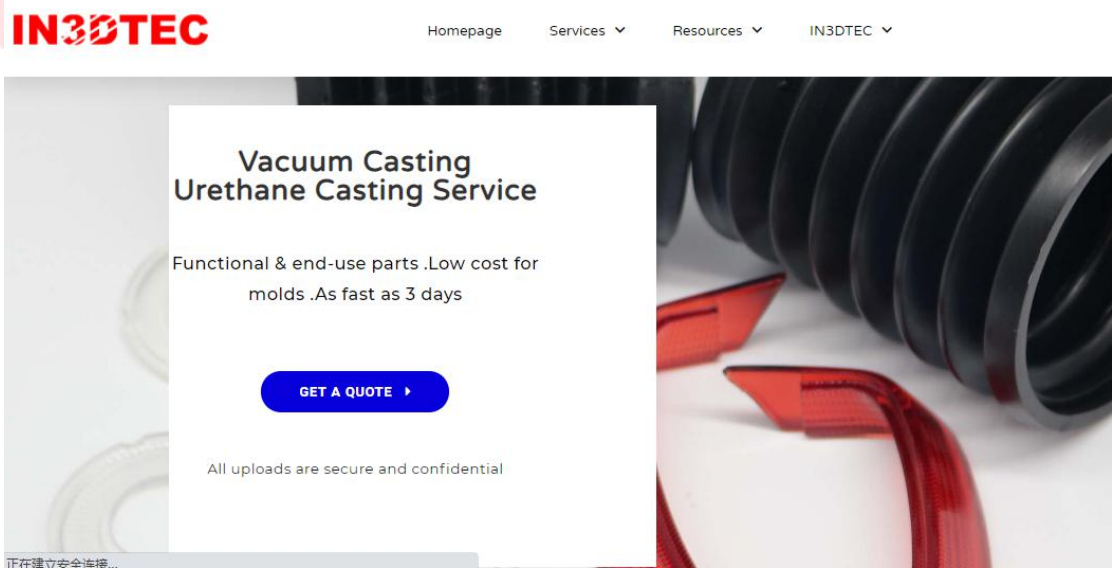
UV resistance:

ASA, PC, Nylons+CF, PEEK, PEI

Flexible materials:

TPU95A & 85A(FDM), TPU75A & 90A(SLS), TPU50A(SLA). For high-standard TPU, we recommend using our Vacuum Casting service, please click HERE to learn more.

Or visit our website to get more details.



3 >> Design tips

3.1 File preparation

Before sending a job to a 3D printer, the model to be printed needs to be tessellated. That means that its geometry needs to be converted into triangles, which are used by the printer to create layers. It is very important to pay attention to this step: if not done correctly, it can cause problems such as inaccuracy or slow processing.

Standard formats in the additive manufacturing industry include 3MF (with more information about the model) and STL.

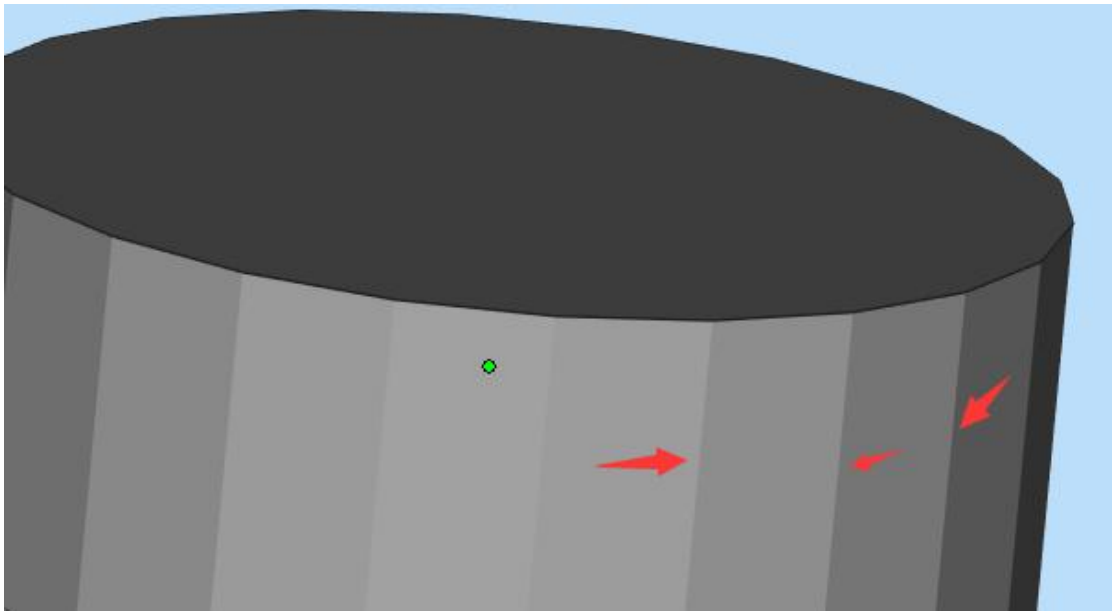
How to export the CAD file into STL? The following tips may help you,

Autodesk Inventors	.Select IPro > Print > 3D Print Preview .Select Options and choose desired resolution and click OK .Within the preview window, select Save Copy .Save As type to STL File (*.stl)
Alire	.File .Export .Save as STL .Save
Iron CAD	.File .Part properties .Rendering .Facet surface smoothing .Save file as STL
Pro E	. File-Export -Model . Set type to STL .Set chord height to 0. The field will be replaced by minimum acceptable value .Set Angle Control to 1 .Click OK
Rhino	.File .Save as STL
Solidworks	.File .Save as STL .Options .Resolution(fine) .OK
Solid Designer (V8)	.File .Save as STL
Solid Designer (Any other versions)	.File .External .Save as STL .Select Binary .Select the model .Input 0.001mm as the Max Deviation Distance(Maximum Tolerance)
Solid Edge	.File .Save as .Select STL . Options - Conversion tolerance as 0.0254mm .Surface plane angle as 45.00
Think 3	.File .Save as STL
Unigraphics	.File .Export .Rapid Prototyping . Binary . Triangle tolerance as 0.0025 .Adjacency Tolerance as 0.12 .Auto Normal Gen as ON .Normal Display as off .Triangle display as ON

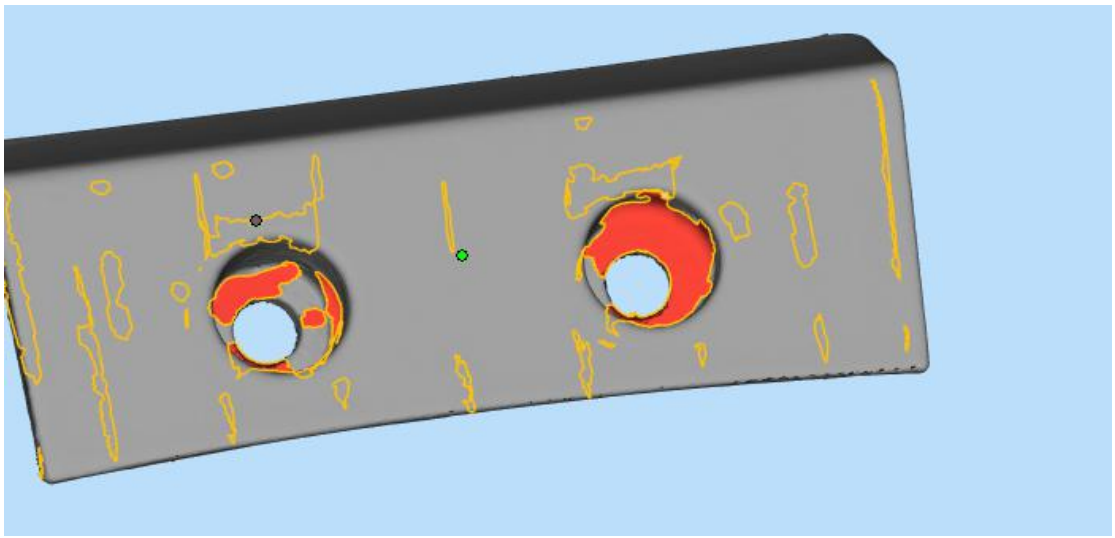
Notes: In order to build on additive manufacturing technologies, STL files must contain completely closed (watertight) polygon mesh objects.

3.2 Common errors of STL

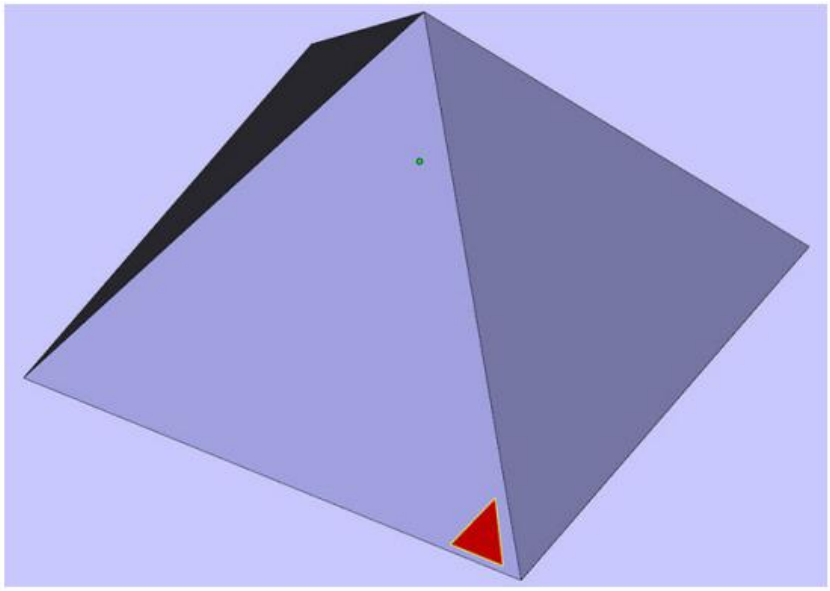
. Bad resolution lead to visible lines on the surface



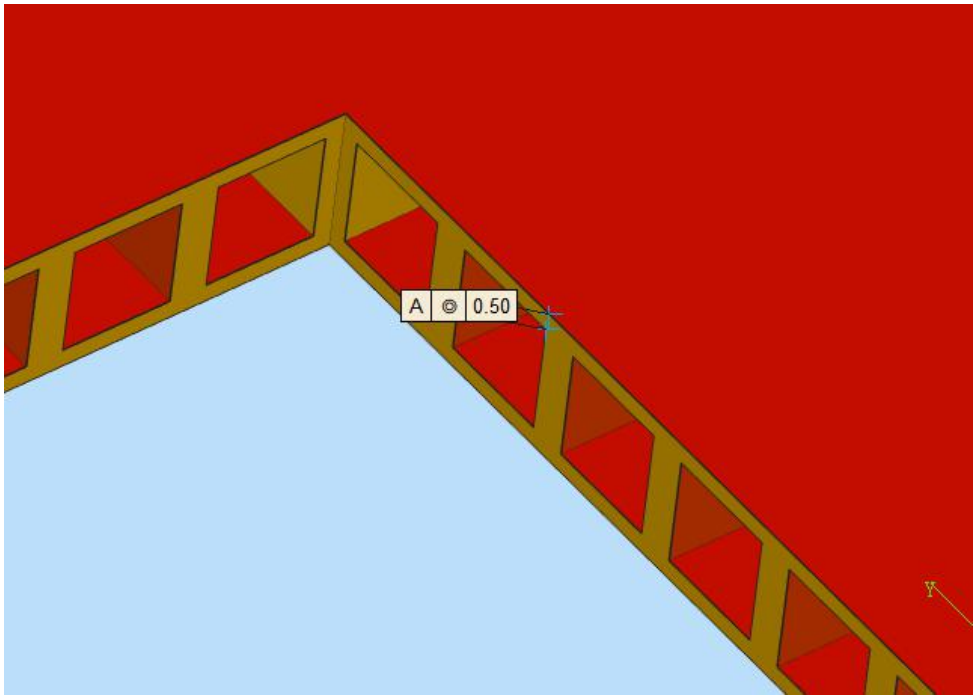
.Broken/not joined surface



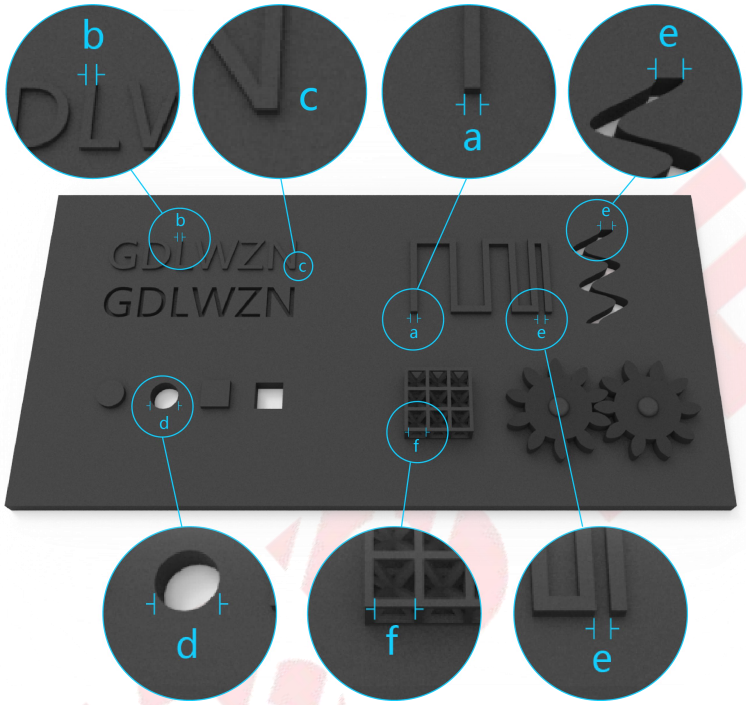
. Holes on the part



.Too thin wall thickness



3.3 Minimum wall thickness、hole diameter、Wall Gap、Font、Assemble gap



Only for FDM

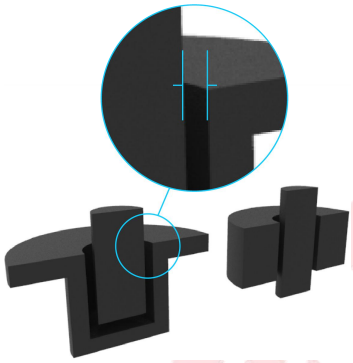
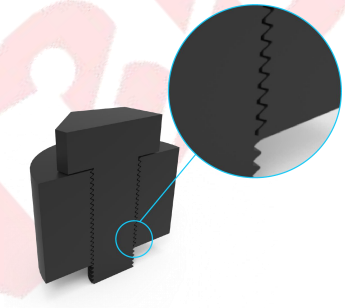
Position	Tips
a	Minimum wall thickness 1.2mm
b	Fonts minimum thickness 0.8mm
c	Fonts height or depth 0.8mm
d	Minimum hole diameter 1.5mm
e	Minimum Gap 0.8mm
f	Minimum Grid wall gap 5mm

For SLA, SLS, SLM

Position	Tips
a	Minimum wall thickness 0.5mm
b	Fonts minimum thickness 0.5mm
c	Fonts height or depth 0.5mm
d	Minimum hole diameter 0.8 mm
e	Minimum Gap 0.5mm
f	Minimum Grid wall gap 5mm

.Parts to be assembled

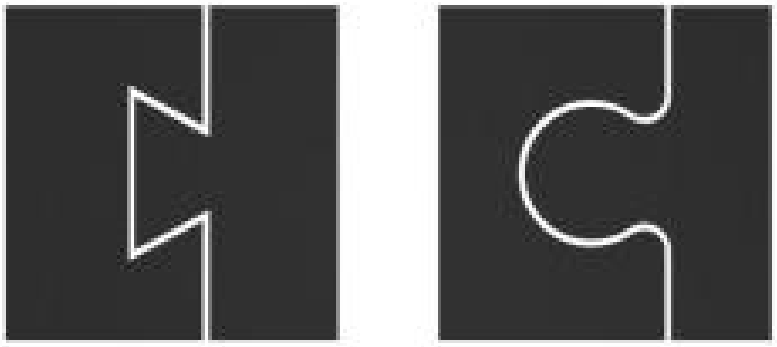
For SLA, SLS, SLM & MJF

Name	Image	Tips
Assemble gap		Minimum assembly gap:0.2mm
Thread		Minimum assembly gap:0.2mm Thread>=M2.5 Minimum thread distance: 0.45mm, Minimum thread height: 0.25mm
Gear		Minimum assembly gap: 0.2mm Minimum thread distance: 2mm Minimum thread height: 2mm

For FDM ones, please contact our team directly.

3.4 More tips:

1. If one of the assembly parts is a 3D printed part and the other is a machined part or an injection molded part, the design should be based on the 0.2mm gap.
2. If both matching parts are 3D printed parts, please design according to the 0.2-0.3mm gap.
3. If your parts exceed our printing size, you can use a reasonable split structure for split printing. We provide you with two types of segmented structures, and the designed gap is also 0.2mm



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>> Methods to save the 3D Printing cost

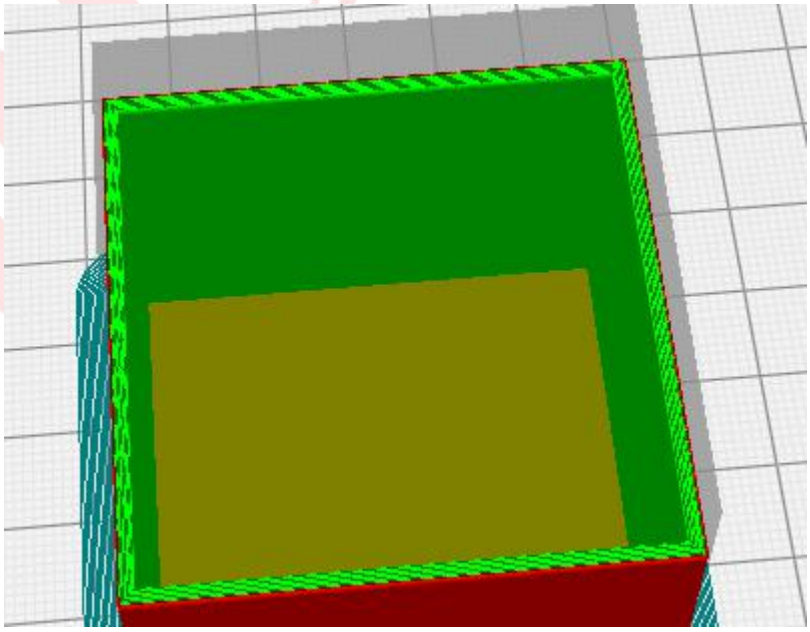
Compared with CNC, 3D printing is not sensitive to the complexity of the objects. For example, in IN3DTEC's China factory, one technician can control 15 to 20 devices at the same time. Therefore, the cost of 3D printing mainly depends on the weight of the part, So the most direct way to reduce costs is to make less weight of the objects, below are 4 free tips,

1. Choose the right material

Plastics:
the cost from high to low following by
PEEK>PEI1010=PPSF>PEI9085>PA+GF>PA+CF>PPS>PPA>PA6/66/12>ASA>PC>PC/ABS>ABS>PETG>PLA

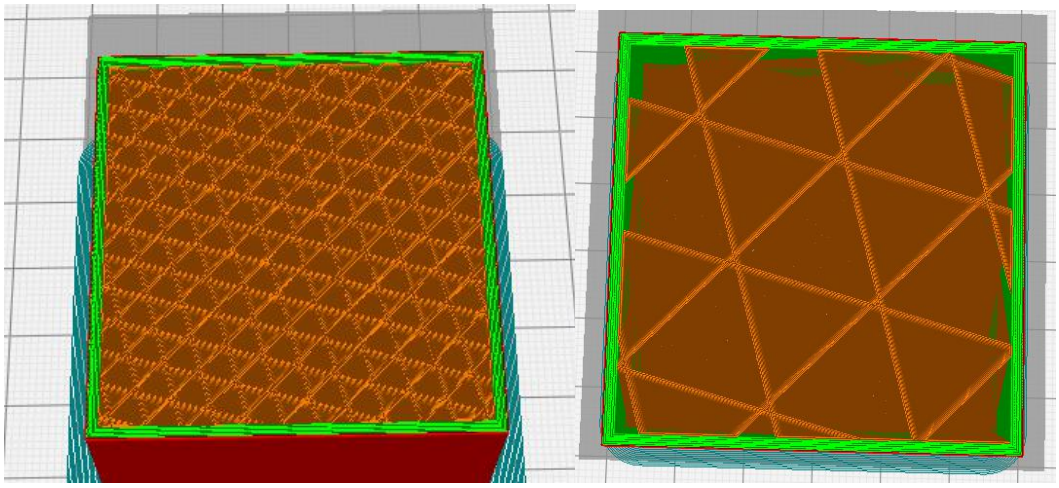
Metals:
Ti64>>18Ni300>Stainless>Aluminum

2. Hollow the part
Samples with low strength requirements can be hollowed

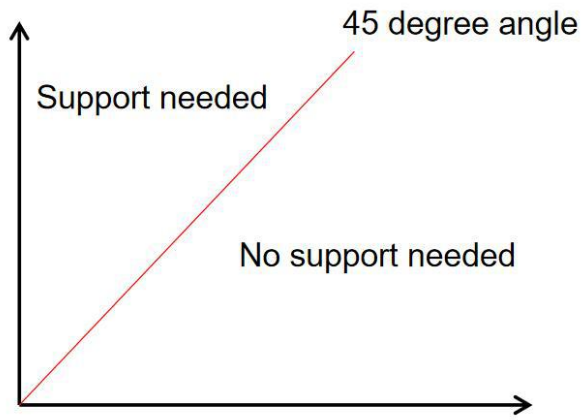


2. Reduce the infill percentage(mainly for FDM)

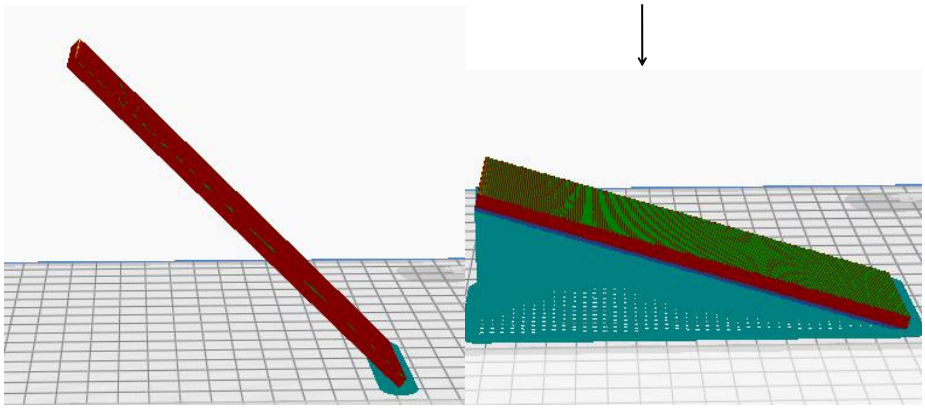
20% infill 5% infill



3. Avoid any structure needs much support

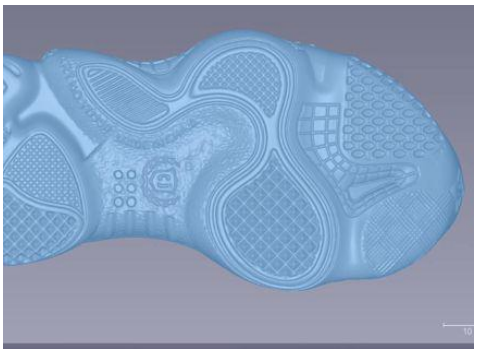


50 degree 30 degree



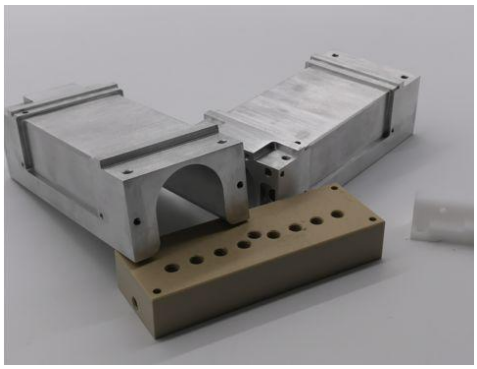
>> About IN3DTEC

Our services



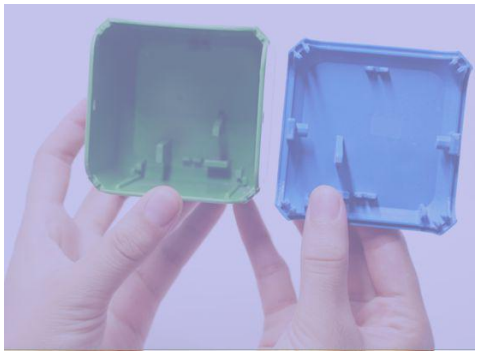
[3D Scanning & Reverse engineering>>](#)

[3D Printing Service>>](#)

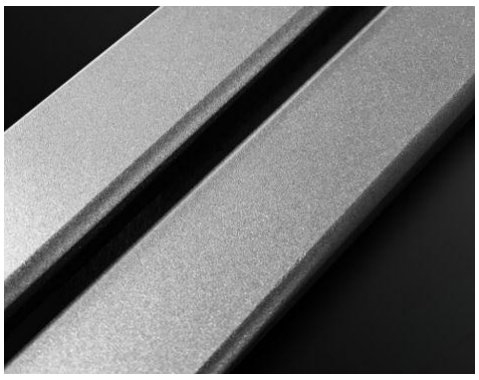


[CNC Machining Service>>](#)

[Vacuum Casting Service>>](#)



[Injection Molding Service>>](#)



[Surface finishes Service>>](#)

Notes:
For chemical and temperature resistance, we refer to the following links, thanks for their effort to making things easier.

https://omnexus.specialchem.com/polymer-properties/properties/hdt-0-46-mpa-67-psi#PE-PL
https://www.curbellplastics.com/Research-Solutions/Technical-Resources/Technical-Resources/Chemical-Resistance-Chart
https://www.plasticsintl.com/chemical-resistance-chart
https://www.gehrplastics.com/wp-content/uploads/2019/07/GEHR-PEI-chemical-resistance.pdf
https://www.coleparmer.com/chemical-resistance

Thank you very much for taking the time to read this manual, and we welcome your comments or suggestions.

IN3DTEC

Bring your concept into reality

IN3DTEC was established in 2014 by a professional team in Shanghai with branches in Hongkong, Suzhou, Shenzhen. We provide a full spectrum of technologies including 3D Scanning, 3D Printing, CNC Machining, Vacuum Casting, Injection Molding and more manufacturing services, which enable us to become a one-stop station from prototyping to on-demand production.

In order to meet different markets needs, we expand our offerings to service Aerospace, Automotive, Education, Electricals, Jigs & Fixtures, Medical, Oil & Gas, Transportation

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