SCOJET INC
PURE PRECISION

ACCELERATE PRODUCTION WITH
METAL 3D PRINTING

DESIGN GUIDE

3D PRINTING IN METAL (SLM)

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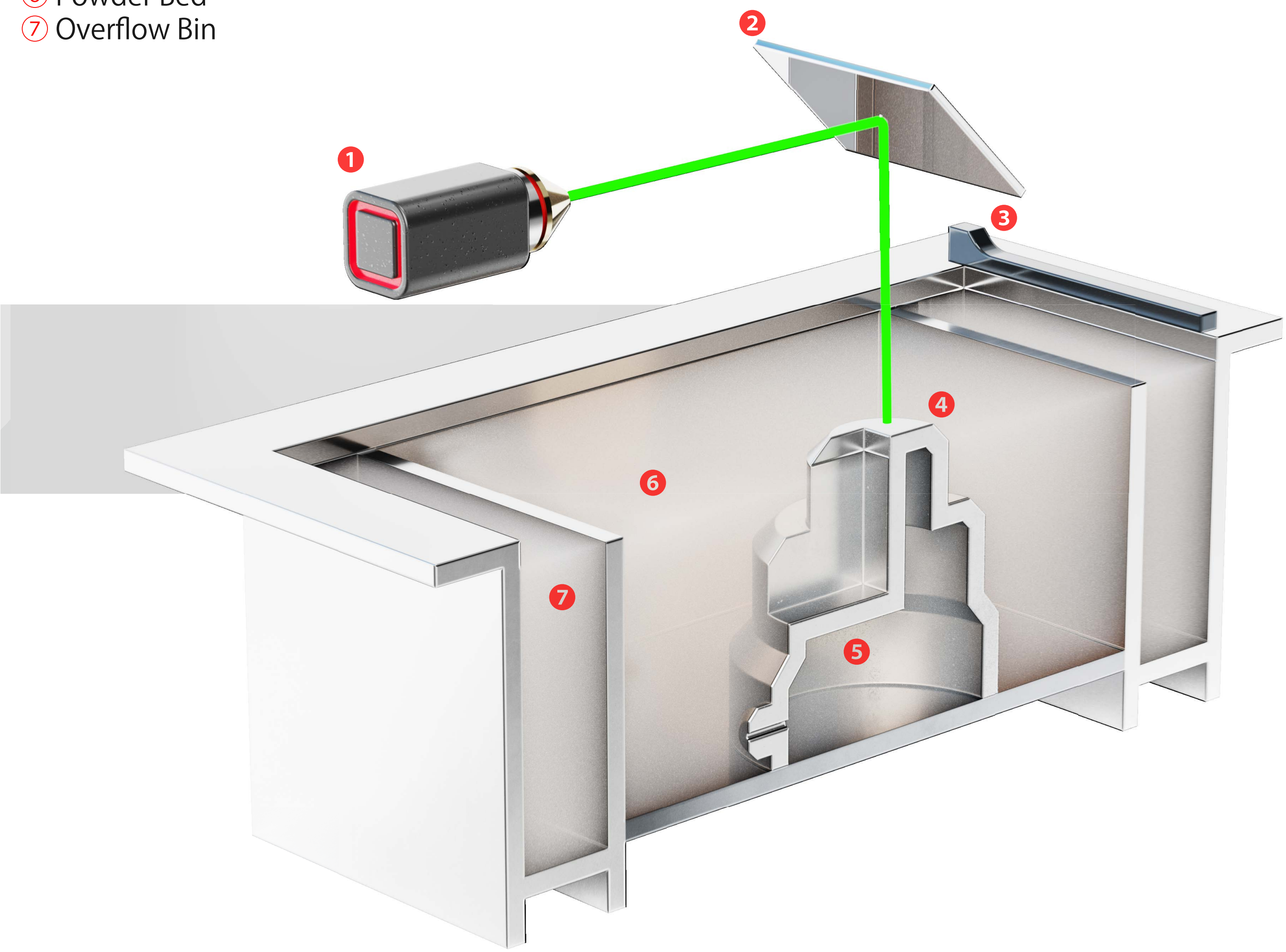
WHAT IS SELECTIVE METAL SINTERING?

A laser directed by a mirror melts metal powder to create parts layer by layer

① Laser
② XY Scanning Mirror
③ Recoater
④ Printed Part
⑤ Support Structure
⑥ Powder Bed
⑦ Overflow Bin



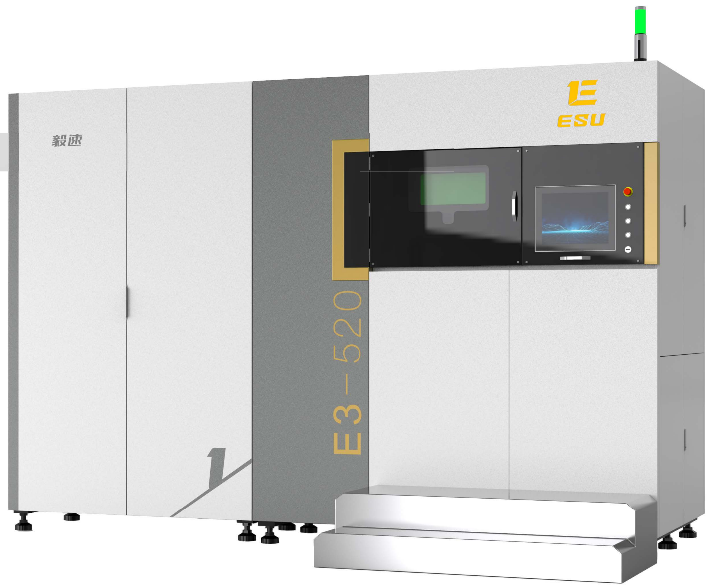
WHAT CAN BE MADE FROM METAL 3D PRINTING?

Selective laser melting (SLM) offers several key benefits when processing metals, which can be fully leveraged with appropriate design adaptations. One of its most notable advantages is the ability to create intricate internal structures, such as cooling channels, or to consolidate multiple assemblies into a single component—capabilities that are not achievable with traditional milling or turning techniques.

Additionally, SLM allows for the production of complex injection mold tooling, providing improved efficiency and functionality in mold design.
In lightweight construction, particularly for aerospace and automotive applications, SLM contributes to significant weight reduction while enhancing the performance of products. Organic, nature-inspired structures open up entirely new design possibilities. Furthermore, components can be produced directly from CAD models, allowing for rapid production and easy adaptation or modification at any stage of the process.

MACHINE SPECIFICATIONS

Scojet, Inc can provide parts manufactured to order.
Do you have questions? Don't hesitate to reach out.



E3 Technical Specifications

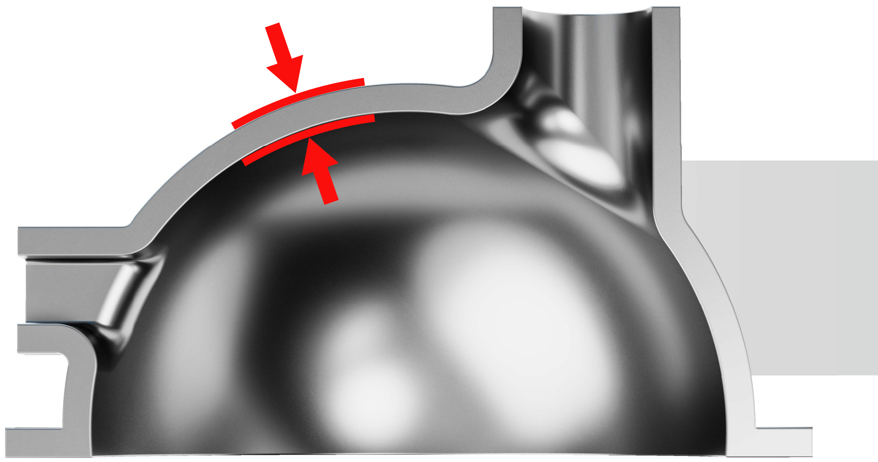
PRINT AREA (including substrate thickness)	E3-520 400×400×520mm	E3-420 400×400×420mm
LAYER HEIGHT	20~100μm	
PART DENSITY	99.99%	
DIMENSIONAL ACCURACY	±0.1mm for dimensions ≤100mm ±0.1% for dimensions >100mm	
REPEATABILITY	±.02mm	
FLATNESS	±.033mm	
LASER POWER	500W*2/3/4	
LASER QUALITY	M2<1.1	
MAXIMUM SCANNING SPEED	7m/s	
OXYGEN CONTENT	≤100ppm	
MAXIMUM POWDER	≤16kW; ≤17.6kW; ≤19.2kW	
SUPPLY VOLTAGE	AC380V 3Ph/N/PE	
PRINTING MATERIALS	Titanium alloys, Aluminum alloys Super alloys, Cobalt-chromium alloys Mold steel, Stainless steel High strength steel, Cast steel	

Parts dimensionally larger than the print area can be printed in pieces and joined after processing

GENERAL GUIDELINES

Wall Thickness

In 3D printing, wall thickness refers to the distance between one surface of a model and the opposite parallel surface. For Standard Grade printing, the minimum allowable wall thickness is 1 mm, while for Performance Grade, it's 0.5 mm. However, the ideal minimum thickness can vary depending on factors such as the geometry and size of the part. For structural walls or features, a recommended thickness of 2 mm is advised.



Although there is no strict maximum wall thickness, it's important to note that thicker sections can increase internal stresses, potentially causing deformations and leading to an unstable printing process.

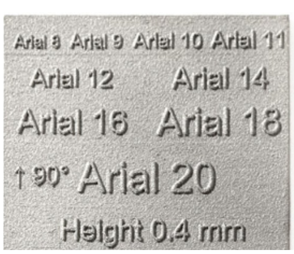
GENERAL GUIDELINES

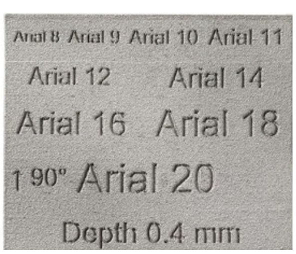
Detail Size

With metal 3D printing very fine details as small as 0.5 mm can be achieved. Detail size refers to the distance between the surface of your model and the surface of the specific feature.

Embossed and engraved text are also considered details, but since printability and readability can vary depending on the print orientation, a general recommendation is to use Arial 20 pt font with a minimum height and depth of 0.4 mm for such text.

As results may differ depending on the font, Arial 20 pt serves as a reliable reference, with a line thickness of 0.7 mm and a minimum text height of 5 mm. For an understanding of how these specifications affect print quality, refer to the examples below, shown in the best possible orientation for Standard Grade printing.



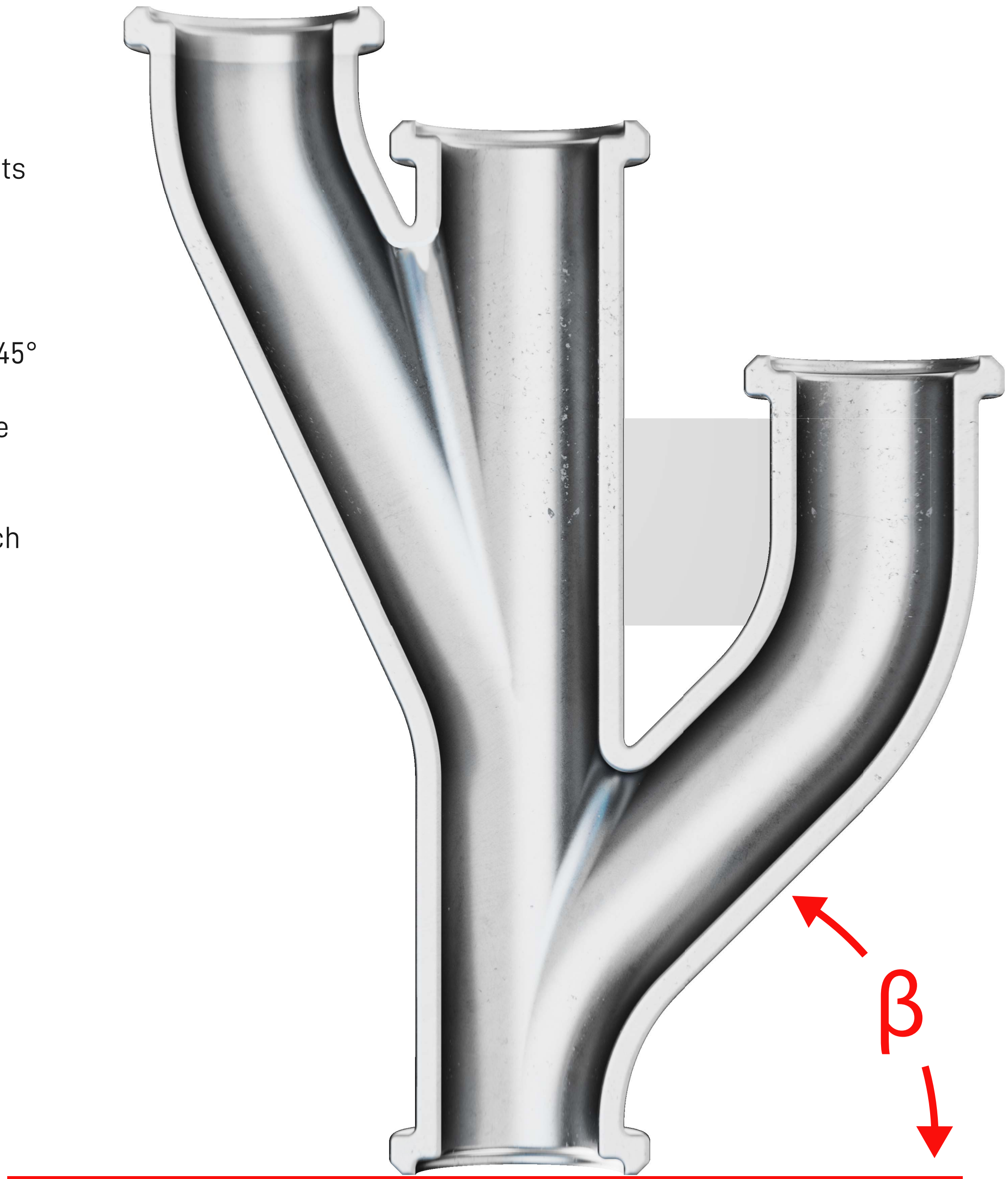


GENERAL GUIDELINES

Surface Quality and Orientation

The orientation of a part during the buildup process significantly affects its surface quality, as it determines how the part's surfaces align with the horizontal plane or build plate.

Surfaces with angles (β) of less than 45° relative to the build plate generally result in poorer surface finishes, while steeper angles above 45° tend to produce smoother, higher-quality surfaces. Overhanging structures, such as the underside of a table, are particularly prone to rougher surface quality.

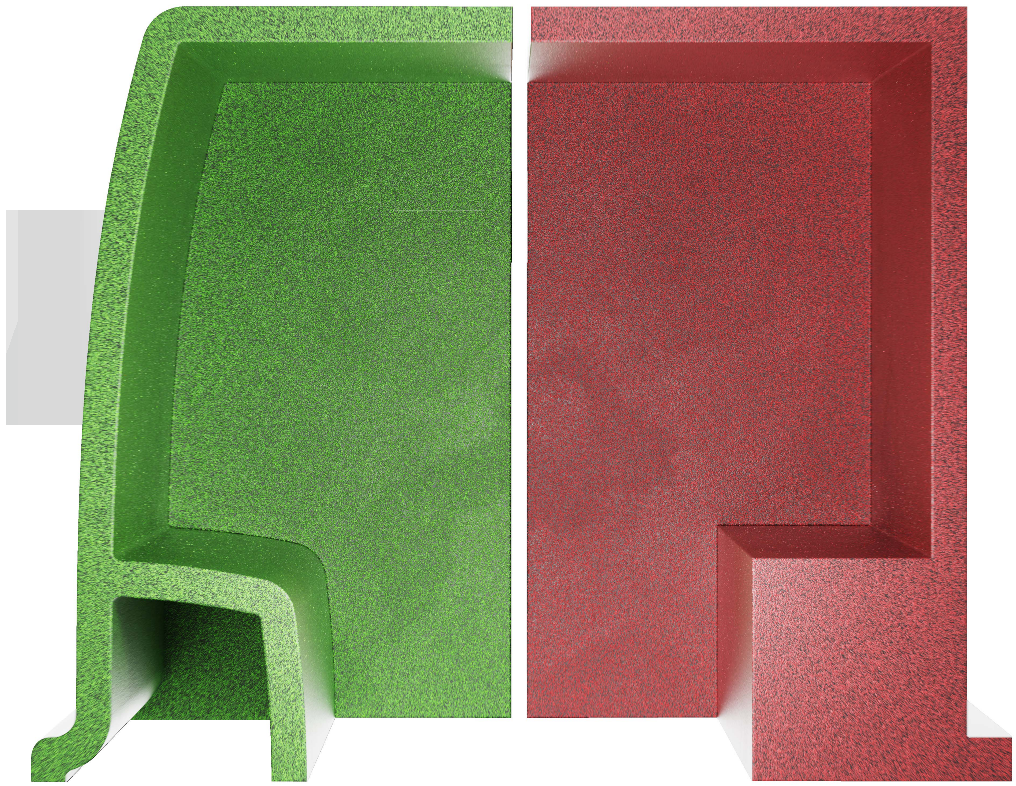


GENERAL GUIDELINES

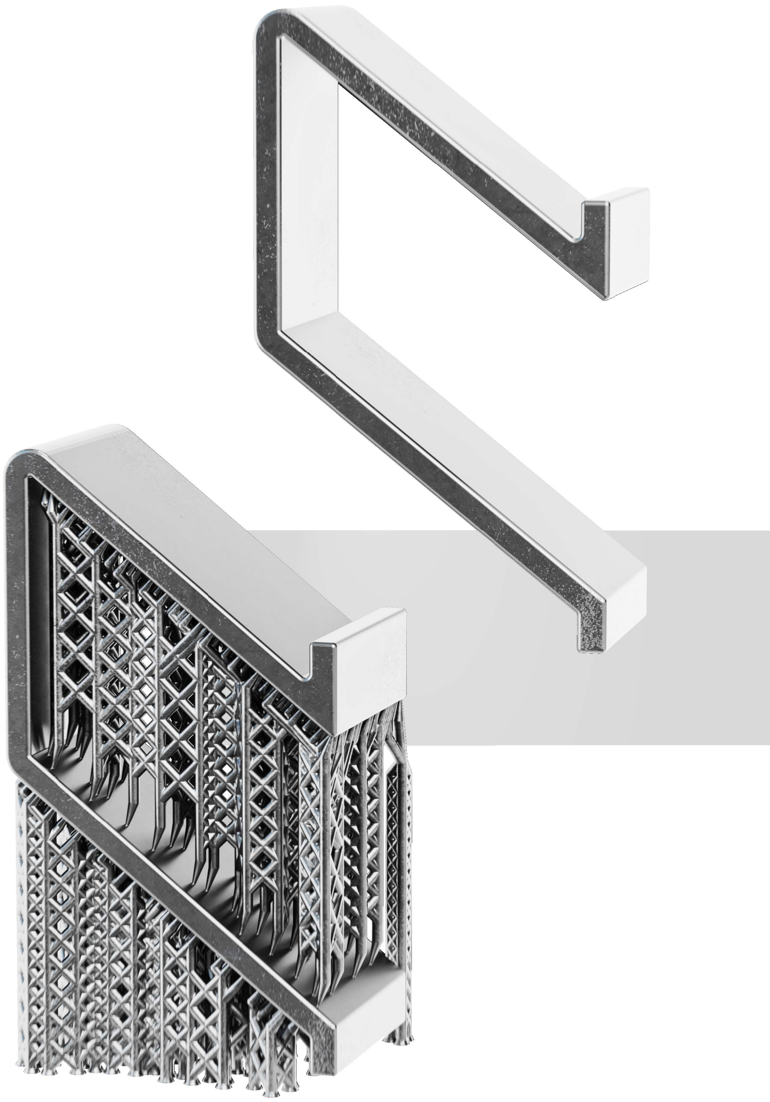
Thermally Induced Stresses

Selective Laser Melting (SLM) metal 3D printing, a layer-by-layer welding process, generates thermally induced stresses as the melted powder solidifies and cools. These stresses can lead to deformations or even build failures if the design is not well-suited for this process.

To prevent such issues, it is crucial to account for the specific constraints of metal 3D printing during the design phase. It is recommended to round or fillet edges with a minimum radius of 3 mm and avoid sharp corners, which can exacerbate stress concentrations. Additionally, large material accumulations should be minimized, and organic, flowing shapes should be preferred over angular or edged designs to ensure better stability and success in printing.



GENERAL GUIDELINES



Supports

Metal 3D printing is a layer-by-layer manufacturing process, where a part is constructed according to a digital file. Depending on the orientation of the part's surfaces, support structures may be required during printing.

These supports ensure the part remains securely connected to the build platform, absorbing internal stresses and preventing deformations. Typically, walls or overhangs with angles below 45° relative to the build platform need support, as they are prone to building errors without it.

Once the part is completed, the support structures are removed, and the part is sandblasted, though slight traces of the removed supports may still be visible.

Polishing and finishing can be implemented to remove traces of removed supports.

GENERAL GUIDELINES

Powder Removal

When designing a hollow model, it's crucial to incorporate at least one hole to enable the removal of unused powder from the cavity. Ensure a minimum wall thickness of 1 mm and include at least one opening with a diameter of 3 mm for powder evacuation. For larger or more intricate cavities, use multiple holes with diameters of at least 7 mm.

Placing holes in the central areas of your model is generally most effective for powder removal. Avoid designing powder traps within the hollow sections to ensure complete powder evacuation. While the printing process can create parts that are air- or water-tight, we cannot guarantee these properties, as they depend on factors beyond wall thickness and applied pressure.

We recommend testing your specific application to confirm functionality.

GENERAL GUIDELINES

Hole Sizes

The minimum recommended diameter for a hole in your design is 2 mm. This size is essential for effectively removing internal powder; holes smaller than this can cause powder to become trapped inside the geometry. Complex or irregularly shaped holes and interior spaces are difficult to inspect and fully clear of powder.

For longer and more intricate internal channels, a larger minimum diameter is required to ensure proper powder removal. Consequently, achieving a print result that precisely matches the CAD designs may be challenging. We strongly advise avoiding long internal channels in metal 3D printing unless you consult with a Scojet project manager to review your files.

For bores requiring high precision, consider adding offsets or fully closing the holes during printing. The part can be post-machined afterward to meet specific tolerance requirements.

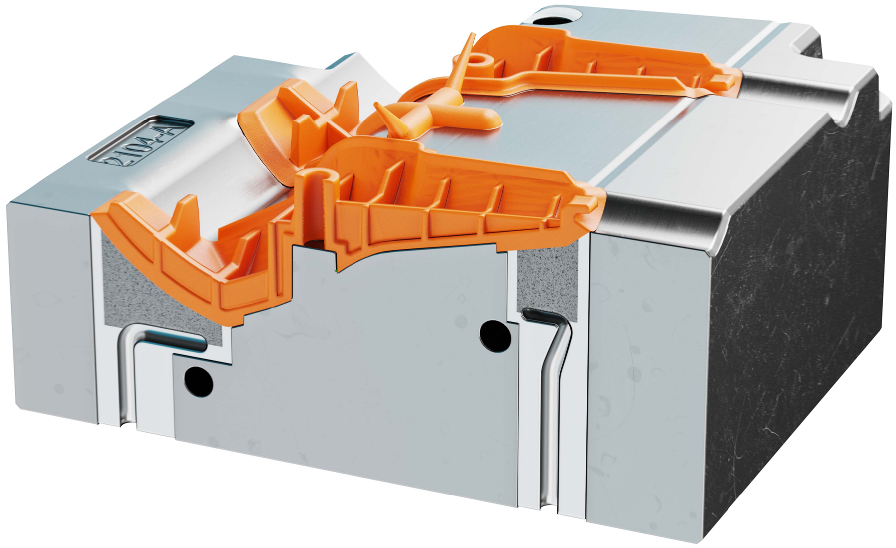
GENERAL GUIDELINES

Breathable Metal

The recommended porosity for breathable metal in injection molds ranges from 10% to 25%, enabling effective gas and heat dissipation during molding. Low porosity risks trapping gases, leading to defects like air pockets, while higher porosity improves venting but can weaken the mold, particularly in high-pressure areas.

For high-stress zones like gates or inserts, consider thicker walls or gradient porosity to balance strength and breathability. Proper CAD detailing is vital, as 3D printing may deviate slightly from the design, so consulting a Scojet 3D printing engineer is advisable.

Post-processing, such as ultrasonic cleaning, is often needed to remove residual powder. Additionally, take care during finishing to avoid sealing porous sections, which could impact airflow and mold performance.



GENERAL GUIDELINES

Conformal Cooling Channels

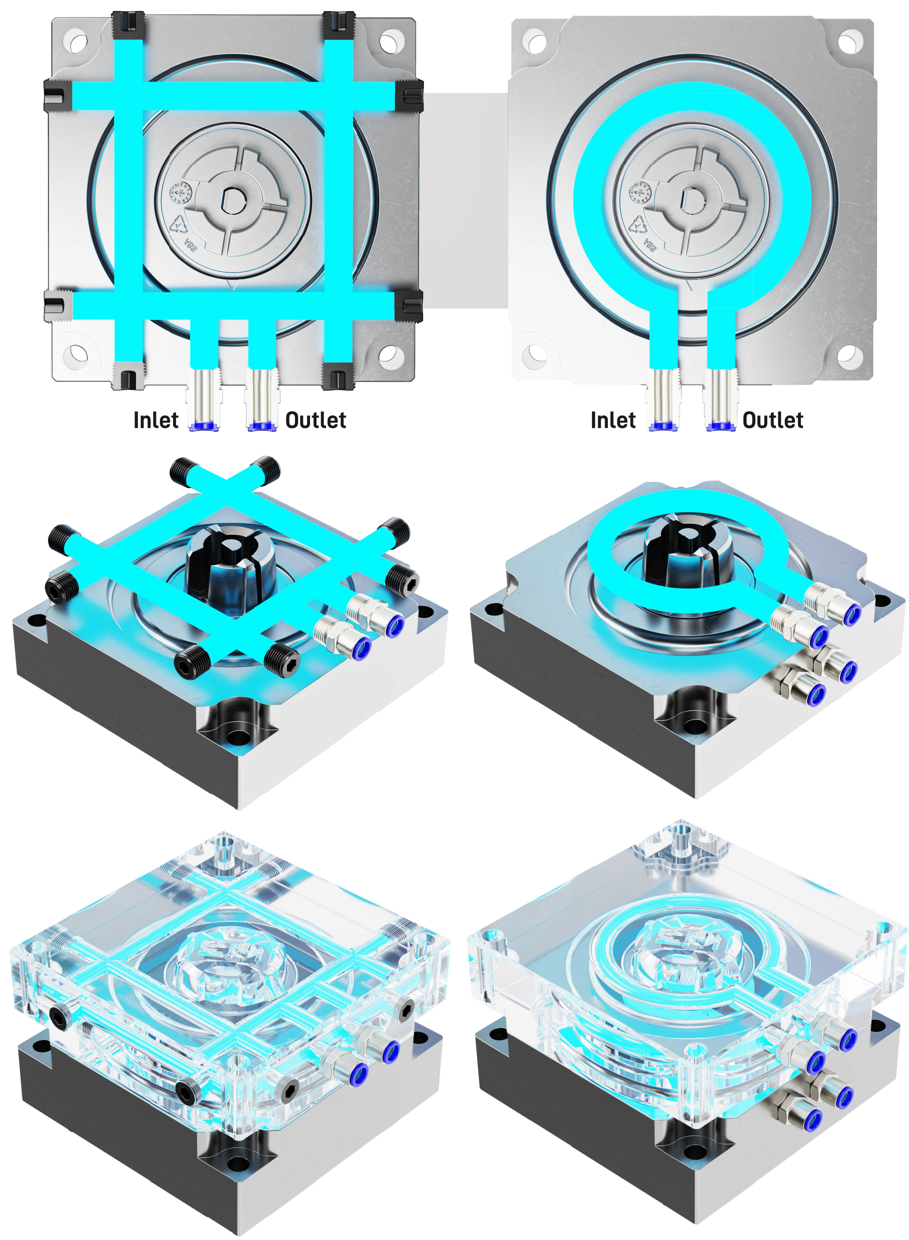
Conformal cooling channels in metal 3D printed injection molds follow the contours of the mold cavity, offering significantly improved cooling efficiency over traditional straight channels. This optimized design helps reduce cycle times and ensures even cooling, which minimizes warping and improves the quality of molded parts.

For optimal performance, channels should be placed as close to the cavity surface as possible, typically maintaining a distance of 2-3 mm. Diameters of 3-6 mm are often recommended for proper flow and effective heat transfer. Ensure the channels have smooth paths to prevent flow disruptions, as sharp corners can impede coolant flow, causing hot spots.

Post-processing, including cleaning and finishing, is essential to clear residual powder from channels. Properly sized channels and cleaning ensure that the mold maintains its conformal cooling performance over time.

For more complex designs, contact Scojet 3D printing experts to confirm that the cooling channels conform to design specifications and material limitations of the printing process.

Traditional Cooling | **Conformal Cooling**



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