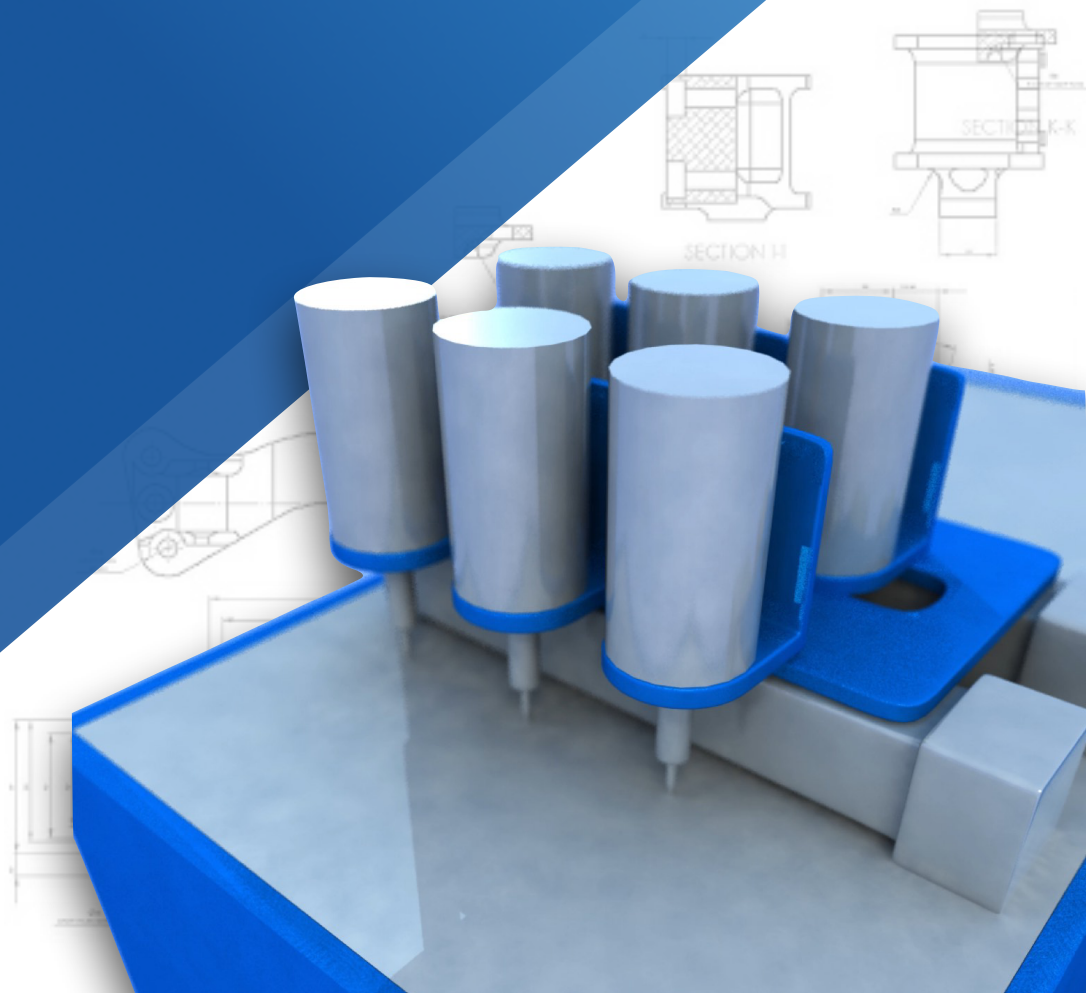


# 3DEO

## INTELLIGENT LAYERING®

Patented Metal 3D Printing Technology  
*For High Volume Production*



# INTRODUCTION

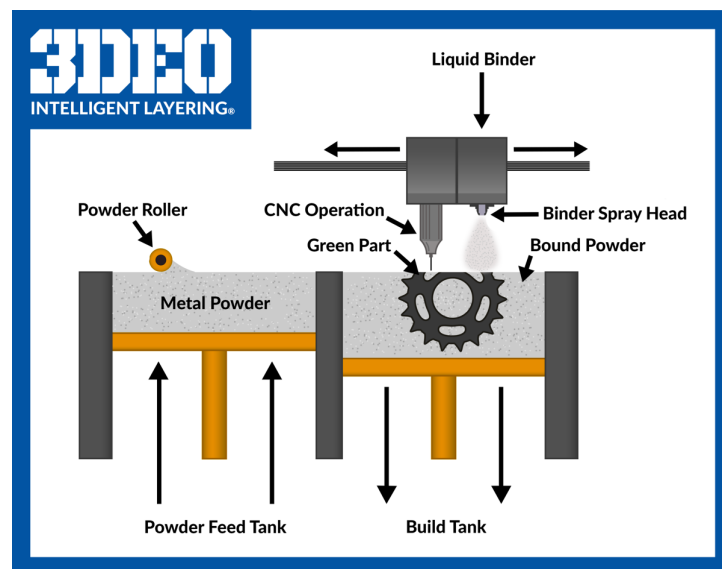
In the realm of additive manufacturing (AM), there are many benefits and possibilities when it comes to metal 3D printing. Unlike traditional manufacturing methods such as metal injection molding (MIM) or CNC machining, metal 3D printing gives you design freedom, manufacturing flexibility, and unprecedented speed to market. There are few geometric limitations and updating designs is painless since there are no molds, tooling, or lengthy setup times. More and more, 3D printing is able to compete on a cost basis with traditional manufacturing with the right types of parts.

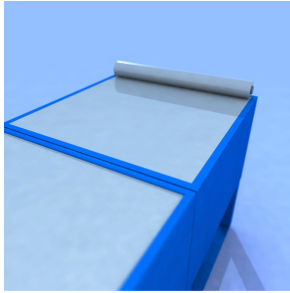
3DEO uses Intelligent Layering®, a patented “bind and sinter” technology. Competing with traditional processes, it was designed specifically to tackle the challenges of cost and low throughput typically associated with metal additive manufacturing.



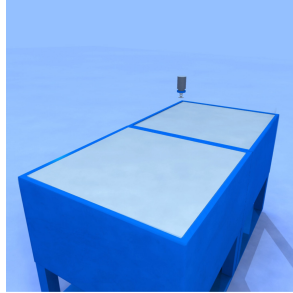
# INTRODUCTION TO INTELLIGENT LAYERING®

Intelligent Layering® is a proprietary process unlike any other in metal 3D printing. Unlike binder jetting, Intelligent Layering® does not use an inkjet printhead. Once a layer of MIM powder is spread, a reliable, low-cost spray head indiscriminately deposits binder across the whole layer as opposed to specified areas with inkjet. This is because the binder deposition isn't used to produce the ultimate shape of the part. Instead, a second pass with a CNC micro end mill is used to define the perimeter of the part on any internal features on a layer-by-layer basis. It cuts into the bound powder at the perimeter of all the layer features, tracing the outline of the part after the binder has been sprayed. This process is repeated one layer at a time until the part is complete. Once built, the part is removed and cleaned, and the green-state object is sintered in a furnace. After sintering, you have a dense, essentially finished part that can then be post-processed however it needs to be (machined, surface finished, bead blasted, or polished). At this point it is a dense metal part ready for end-use applications.

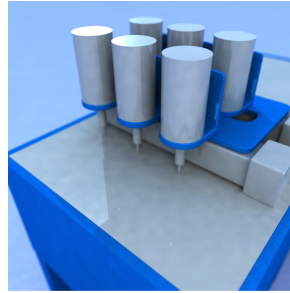




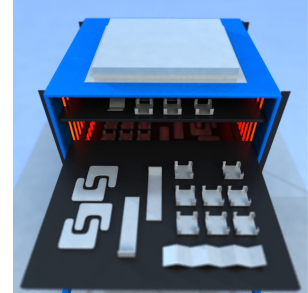
Layer of MIM powder rolled onto build tray



Binder deposited across entire layer of powder



End mill cuts out desired layers or edges

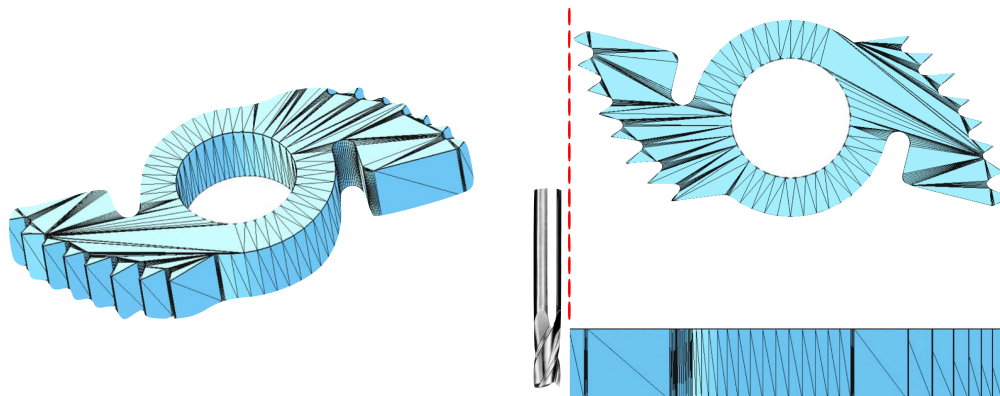


Green parts are sintered in furnace to achieve final density

## CAPABILITIES OF INTELLIGENT LAYERING®

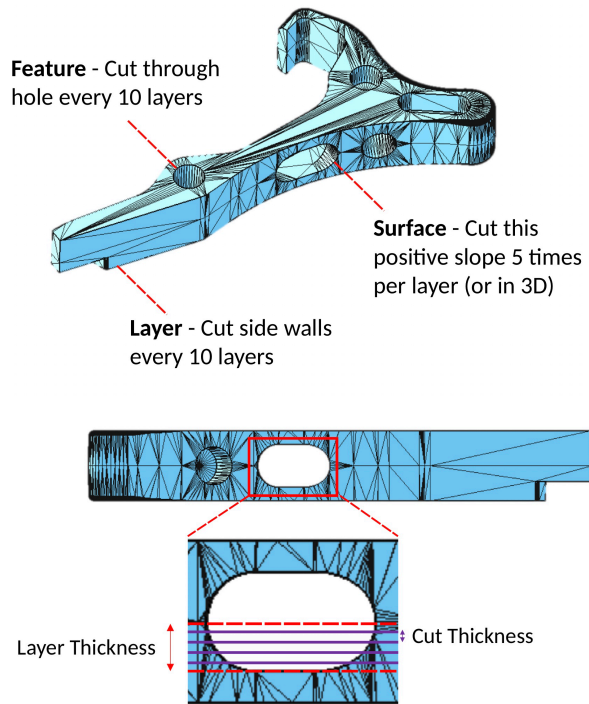
Using an end mill to cut the green part in powder form allows for unique abilities in the 3D printing space that no other technology can do. With Intelligent Layering® you can apply feature based strategies like multi-layer processing and dynamic layer thickness.

One of the primary capabilities of this technology is high speed. A part can be as complex as you want, but many layers can be cut simultaneously. Depending on the features of the part, this can be significantly faster than a design that may involve more geometry or sloped sides.



2.5D geometry with angled features in the vertical direction, no undercuts

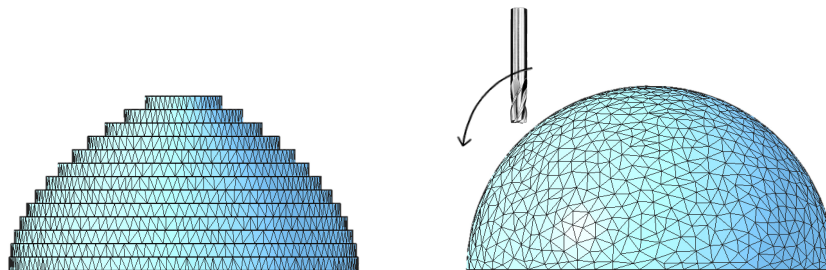




In this example, there are 5 cut depths for 1 layer thickness

The process can also be taken in the other direction; instead of high speed being the goal, vertical resolution may be more desirable. In this case, a whole layer can be bound and thinner sections can be cut in one pass. Essentially, it is intra-layer feature recognition, allowing for high resolution and the ability to remove some of the stair stepping features commonly seen elsewhere in 3D printing technology. Stair stepping is an integral feature to all 3D printed parts. Thinner layers result in less stair stepping, but it takes longer to build the part.

Depending on the design and features, Intelligent Layering® can combine all three of these capabilities in a single part. It can cut a whole flat surface at once with 2.5D, but it can also process multiple layers at a single time and operate with angled features in the vertical direction. It can cut in three dimensions and remove all the stair-stepping, optimizing production for this part to get the fastest time, most throughput, and cheapest part at the end of the day for the customer. Where traditional AM creates parts one layer at a time, Intelligent Layering® provides optimized control at the layer, feature, and surface level.



Stair stepping

# TECHNICAL SPECIFICATIONS

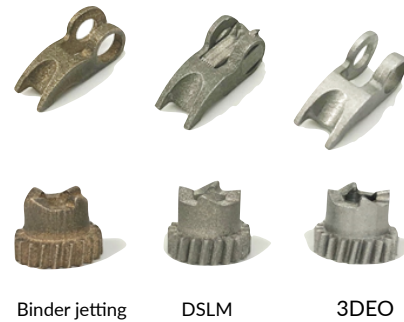
General Tolerances	± .002 - .004 in. (.05-0.1mm) as built
Hardness	34 HRC / 42 HRC with heat treat
Density	99.5% density (far better than MIM)
Surface Finish	60-70 Ra (best in metal 3D printing)
Min. Feature Size	0.030" (0.76 mm)
Component Size	1 Inch <sup>3</sup> (23mm <sup>3</sup> ) (not a technical limitation)

## POWDER PROPERTIES

Chemical Composition (wt%)	Minimum	Maximum
<b>Element</b>		
Carbon (C)	-	.07
Manganese (Mn)	-	1
Phosphorus (P)	-	.04
Sulfur (S)	-	.03
Silicon (Si)	-	1
Chromium (Cr)	15	17.5
Nickel (Ni)	3	5
Copper (Cu)	3	5
Niobium & Tantalum (Nb+Ta)	.15	.45
Iron (Fe)	Balance	Balance

Other Elements: Total may not exceed 1.0% combined. Same chemical composition as the built parts. In Accordance with MPIF Standard 35 (2016 Edition), and ASTM UNS S17400 (12th Edition).

## Process Comparison



Binder jetting

DSLM

3DEO

## TYPICAL MATERIAL PROPERTIES

	As-sintered	Heat-treated*	Standard
Ultimate Tensile Strength	1000 MPa (145 ksi)	1317 MPa (191 ksi)	ASTM E8/E8M
Yield Strength (0.2% offset)	750 MPa (109 ksi)	1172 MPa (170 ksi)	
Elongation to Failure	7%	10%	
Elastic Modulus	185 GPa (26.8 msi)	-	
Hardness	34 HRC	42 HRC	ASTM E18
Notched Charpy Impact Energy	19 J (14 ft-lbs)	-	ASTM E26
Relative Density	>99%		ASTM B962
Density	7.68 g/cm³ (0.278 lbs/in³)		
Surface Roughness (Ra)	3.0 µm (120 µin)		ASTM B946
Corrosion	Pass		ASTM F1089
Tolerances	± 0.001 in/in**		

\* Heat treatment condition: H900. Additional heat treatment options available upon request.

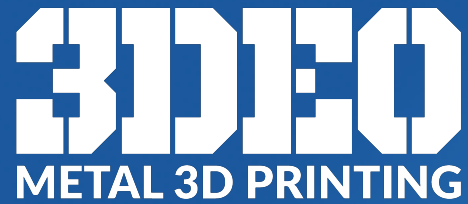
\*\* ± 0.004 in/in as sintered, ± 0.001 in/in possible with secondary machining operations.

The performance characteristics of these materials may vary according to application, operating conditions, or end use. Each buyer is responsible for determining that the material is safe, lawful, and technically suitable for the intended application. 3DEO makes no warranties, express or implied, including, but not limited to, the warranties of merchantability, fitness for a particular use, or warranty against patent infringement. Product specifications are subject to change without notice. 17-4PH Stainless Steel

©2019 3DEO, Inc. All rights reserved. Rev. 01/2019

# INTELLIGENT LAYERING®

## ADVANTAGES & DISADVANTAGES



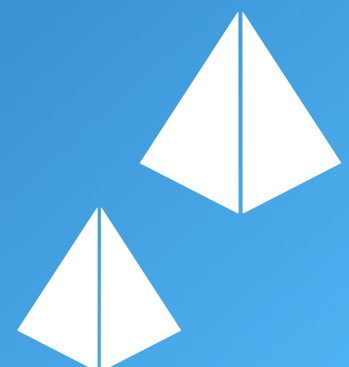
### ADVANTAGES

Intelligent Layering® was specifically designed to tackle the cost and low throughput problems typically associated with metal additive manufacturing. The result is an ultra-low-cost machine that virtually eliminates machine amortization as a part cost driver. It also attacks cost through the use of commodity metal powders, which can be as much as twenty times less costly than powders used in powder bed fusion. Also, there are no degrading processes in Intelligent Layering®, so part-to-part and machine-to-machine repeatability enables a high yield process. As a result of the tightly packed fine powder, at ~100 Ra, 3DEO has one of the best surfaces in all of metal additive manufacturing in the as-sintered state.

### DISADVANTAGES

Similar to other bind-and-sinter technologies such as binder jetting, Intelligent Layering® is limited by the 18-20% shrinkage factor that happens in the sintering cycle. When metal powder is bulk sintered in a furnace, there is a certain amount of shrinkage that takes place as the voids between metal particles disappear and the particles fuse together. This shrinkage is predictable and can be dialed in for each part geometry that is encountered, but it is certainly a disadvantage of the process.

ADVANTAGES	DISADVANTAGES
Ultra low-cost process	Significant part shrinkage in furnace
Very nice surface finish	Company sells parts, not machines
Material properties of 17-4PH exceeds MPIF Standard 35	Process is ideal for smaller parts (~3" longest dimension)
No degrading process leads to high yield and high uptime, lowering final part cost	Only 17-4PH stainless steel is in production today



## WHAT MAKES 3DEO DIFFERENT?

3DEO does not sell machines, but supplies parts. With no molds, tooling, or lengthy setup times, 3DEO delivers production parts in days or weeks, not months. While there are many competent metal AM providers, none of them fully control their machines. This is a fundamental difference between 3DEO's operation and how other current contract manufacturers in the 3D printing space. 3DEO controls the full software and hardware stack. They see their entire production line as their technological scope, from powder to QC to parts out the door. Thanks to their innovative technology and thorough operation, they are able to provide such high volume, low-cost, high quality parts.

## METAL ADDITIVE MANUFACTURING WITH 3DEO

### **True Design Freedom**

With 3D printing, you have unprecedented design freedom to update and change your design nearly as quickly as you can redesign it in CAD.

### **Short Lead Times**

Respond to market demand quickly, allow your designers to iterate swiftly, and manufacture on demand, only as necessary.

### **Flexible Manufacturing**

Scale quantities up or down to match demand; avoid setup and minimum quantity costs with traditional manufacturing.

### **Lower Risk**

Change designs in real time, fix problems as they arise, lower up front cost to get to production, and manufacture on demand.

# INTELLIGENT LAYERING®

READY TO SEE IT IN ACTION?

[REQUEST SAMPLE KIT](#)

3DEO, Inc.  
24225 Garnier St.  
Torrance, CA 90505