INDO-MIM®

COMPLEXITY SIMPLIFIED

ADDITIVE MANUFACTURING PROCESS

25th March 2025

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GLOBAL PRESENCE

Sales Offices:
- Stuttgart (Germany)
- Yardley- PA (USA)
- Shanghai (China)
- Nagoya (Japan)
- Gyeonggi-do (Korea)

Manufacturing facilities:

MIM Manufacturing
- Bangalore (India)
- Chandler- AZ (USA)
- Suffolk (UK)

Investment Casting
- Tirupati (India)
- San Antonio- TX (USA)

KEY FIGURES

Largest Installed MIM Capacity

- Over 1.17 Mn Sq feet of manufacturing facility
- 250+ molding machines 40 + sintering furnaces
- 6000 plus parts developed
- 75 mold a month tool room capacity

Global footprint

- 6 manufacturing plants located in India, UK & USA
- 4000 + employees
- Technical & sales support offices in Europe, USA & China

85+ Material Options

- Steels, stainless steels, Tool steel, Nickel alloys, Cobalt alloys, Titanium & others
- Zirconia and Alumina oxide ceramic grades

200+ Million parts Shipped Annually

- 96% exports from India plants
- Shipped to 5 continents

DIVERSE TECHNOLOGIES

- Metal Injection Molding
- Ceramic Injection Molding
- Investment Casting
- Precision Machining
- Additive Manufacturing
- Powder Manufacturing

POWDER MANUFACTURING

- World-class Vacuum-Melting Inert gas metal powder production facility
- Applications as primary manufacturing material:
  - Additive Manufacturing
  - Thermal Spray
  - MIM / HIP
- Powder Grades:
  - Stainless steel
  - Cobalt alloys
  - Nickel alloys
  - Tool steel
  - CoCr alloys
  - Other customized powders

TYPES OF ADDITIVE MANUFACTURING

INDO-MIM®
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- Direct Metal Laser Sintering **(DMLS)**
- Binder Jetting **(BJT)**
- Lithography Metal Manufacturing (LMM)
- Stereolithography – Plastic
- Selective Laser Melting (SLM)
- Selective Laser Sintering (SLS)
- Electron Beam Melting (EBM)
- Material Jetting
- Material Extrusion
- Sheet Lamination
- Directed Energy Deposition

MIM/CIM PROCESS

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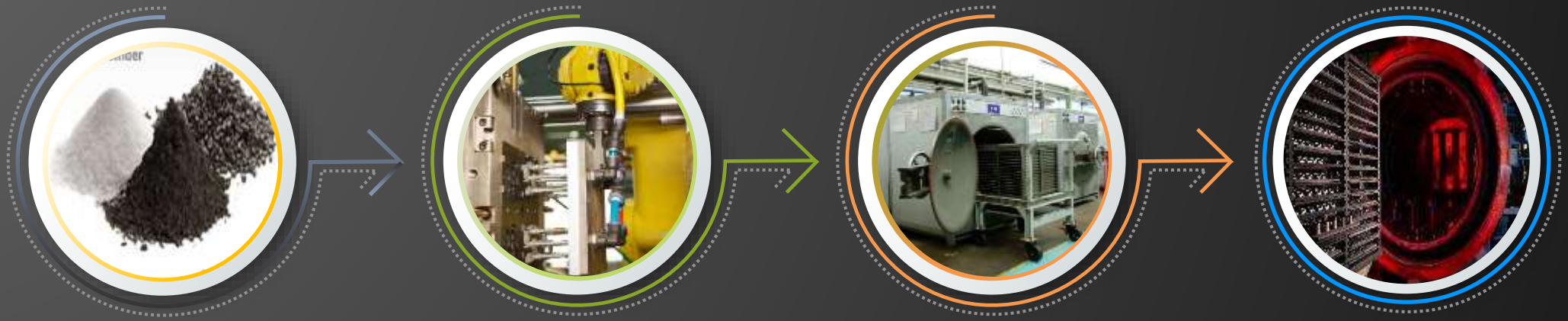


Compounding

Metal/Ceramic
powder + Binder

Injection Molding

Green part

De-binding

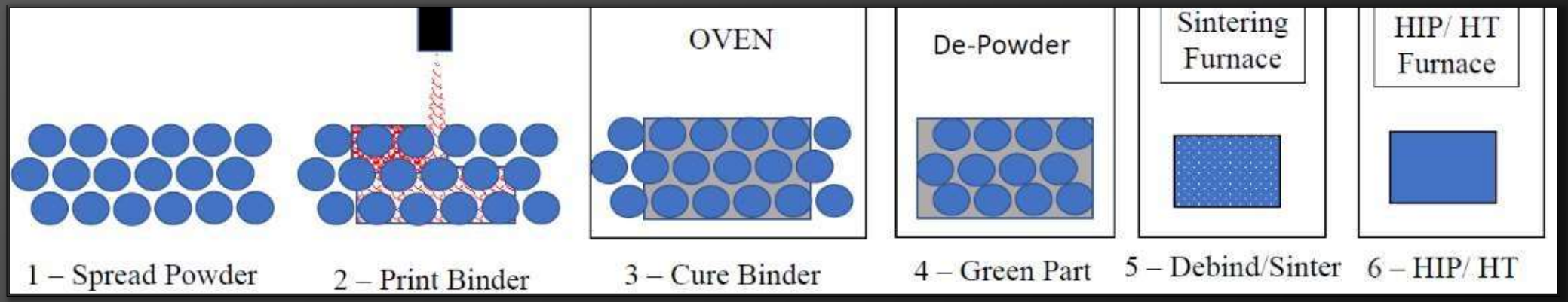
Brown part

Sintering

Sintered part

BINDER JET 3D PROCESS

In Binder Jetting, the binder is selectively deposited/jetted onto the powder bed, bonding these areas together to form a solid part one layer at a time. The materials commonly used in Binder Jetting are metals, sand, and ceramics that come in a powder form.



Step 1: Spread the **Powder** - To achieve consistent powder packing density

Step 2: Jetting **Binder** - To wet the powder particles and to give shape to the components

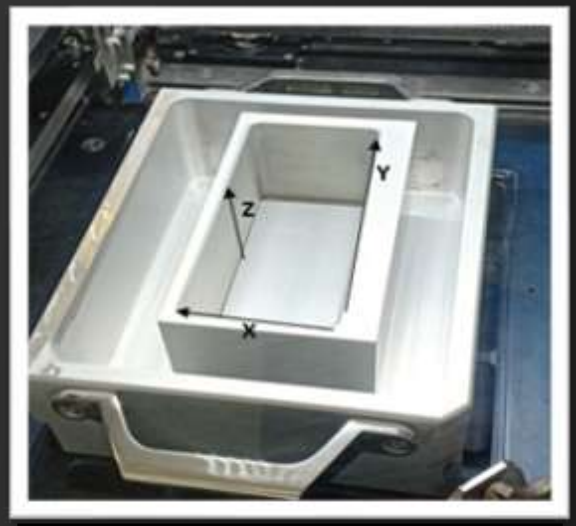
Step 3: **Cure Binder** - Produces enough green strength for handling the components

Step 4: **De-Powdering** - Removal of loose powders to extract green components

Step 5: **De-Binding & Sintering** - To remove extractable binders and to achieve final densification/microstructure

Step 6: **Post Processing** - To achieve desired metallurgical & mechanical properties

BJT – DETAILED PROCESS STEPS



Build box size - 65 x 65 x 160mm

Conditioning of the Powder

- Condition the powder to be moisture free
- Particle size distribution of the powder is important for the Green & Sintered density
- Ensuring uniformity of powder particle size is important

Printing process

- Printing involves 3 steps for every single pass over the build area
  - Powder Spreading
  - Compacting
  - Binder Jetting
- Layer by layer, metal powder and binder are deposited until the entire build volume is packed with bound parts and surrounding loose powders

BJT – Detailed process steps

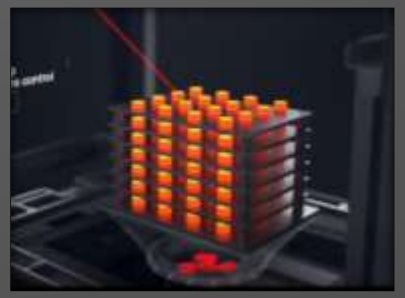
Curing process

- Once the parts are printed, they need to be cured to allow the binder and powder particles to fuse together
- The curing process takes the printed parts to approximately 150 °C for 4 hours
- The binder activates at this temperature to form strong bonds which give sufficient strength to the parts

De-powdering process

- Once the build box is cured, it is moved to the de-powdering station where loose powders are removed & parts are prepared for Sintering
- Allow loose powder to fall to the side of the job box
- Using a brush, carefully clear off the powder being cautious to not damage the part

BJT – Detailed process steps



Sintering process

- Sintering is where the binders are removed from the parts and the metal powders fuse together to form a fully dense metal part
- Sintering Temp: ~1400 °C
- Sintering Cycle Time: 24 to 30 hours (depends on the volume)

Secondary process

- Heat Treatment
- Grit Blasting / Bead blasting
- Rem polishing
- Machining / Finishing
- Plating

BJT – TOLERANCE CAPABILITIES

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FEATURES	CURRENT CAPABILITY
Tolerance (% of feature size)	± 1%
Surface finish (as sintered)	3 ~ 5 Ra
Minimum wall thickness	1.0 mm
Maximum wall thickness	15 mm
Minimum feature size	0.80 mm
Minimum hole diameter	1.50 mm
Maximum aspect ratio	8 : 1
Minimum fillet radius	1.0 mm
Shrinkage as sintered	16% ~ 18%

Process	Binder-Jet 3D printing		
Printers available	Model	Build Box Dimensions (mm)	
Desktop Metal	P1	200 X 100 X 40 (Z)	
Desktop Metal (ExOne)	Innovent+	65 X 160 X 65 (Z)	
Desktop Metal (ExOne)	25 PRO	400 X 250 X 250 (Z)	
Desktop Metal	Shop pro	350 X 222 X 220 (Z)	
HP	SJ 100	430 X 309 X 140 (Z)	
Material Options (Current)	SS 17-4PH	SS 316L	Tool Steel M2
Material density as sintered	98% min	98% min	99.5% min
Material Hardness range post-heatment (based on heat treatment process)	30~42 HRC	~70 HRB	55~ 65 HRC
Material properties	Can be shared upon request		
Minimum wall thickness	1.00 mm (~0.04"). Lower wall thickness need closer review		
Maximum wall thickness	15 mm (~ 0.60")		
Weight Range	3 grams to 10 Kgs		
Maximum part foot print	70% of Build Box dimenssions		
Surface finish	4~7 Ra as sintered (Z direction will have rougher finish)		
	Can be improved upto 0.20 Ra through additional finishing		
Dimentional tolerance	± 1.50% of the feature size		
Flatness	Depends upon product configuration and wall thickness		
Minimum resolution	0.5 mm (0.02") in X-Y direction, 1 mm (0.04") in Z direction		
Suitable production volume (3~30 grams)	10~250,000+ parts/yr per Printer		
Suitable production volume (30~300 grams)	10~10,000 parts/yr per printer		
Secondray finishing offered	CNC turning/ milling, surface grinding ,surface finishing, heat treatment etc.		
Design assistance	Offered through detailed DFAM		
Service locations	Bangalore, India	San Antonio, USA	
Typical leadtime for sample shipment	~ 2 weeks for simple projects, 3~5 weeks for complex projects		
RFQ response time	24~72 hours for simple projects, ~ 10 days for complex projects		

BJT – MATERIAL DEVELOPMENT

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Developed

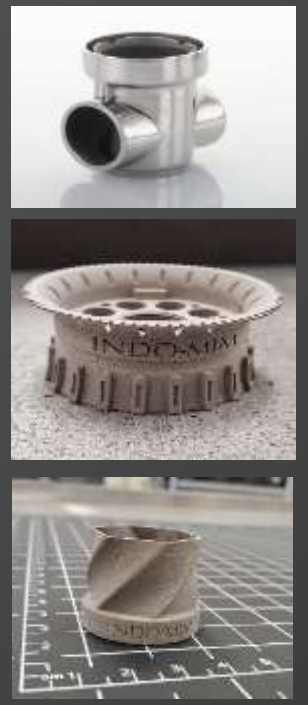
- ❑ SS 17-4 PH
- ❑ SS 316
- ❑ SS 310
- ❑ M2, S7 (Tool steel)

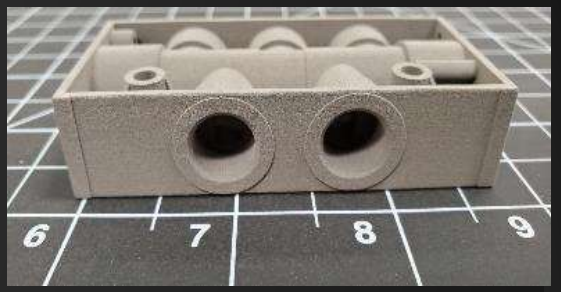
Under development

- ❑ H13
- ❑ 4605
- ❑ 4140
- ❑ SS 420
- ❑ IN 718
- ❑ IN 625

Capability exists to produce customized powders from gas atomization.

BJT – APPLICATION EXAMPLES





- Complex shape
- Thin wall
- Thick wall
- Variable sections
- Undercuts
- Threads
- Gears
- Helical profiles

Automotive → Aerospace → Consumer → Medical → Defence

BJT – CONFORMAL COOLING (CFC)

Conformal cooled inserts

- Primarily used in the Injection molding process
- CFC inserts provide more effective cooling in molding process
- Helps to provide rapid and uniform cooling
- Faster cycle times
- Defect free parts
- Complex cooling geometry is possible only by BJT
- BJT provides better surface finish in the cooling channels
- BJT can be used to produce High carbon alloys, which offers equiaxed grains with isotropic properties
- No support structure required

SOLUTION TO THE MOLDING DEFECTS BY CFC

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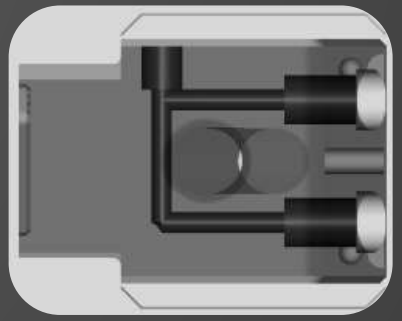
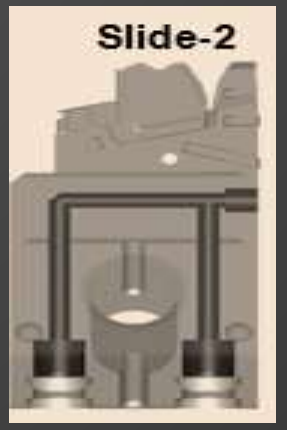
Conventional cooling inserts

100 % Sink @
Green stage

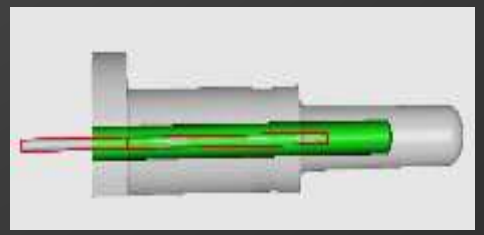


Sink & distortion

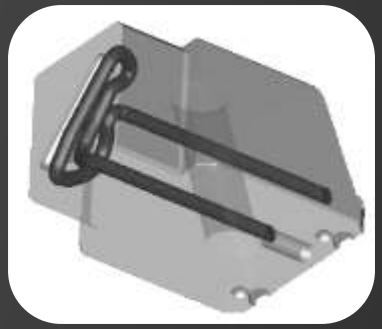


GENERAL / EXTERNAL

Sink & Chip-off

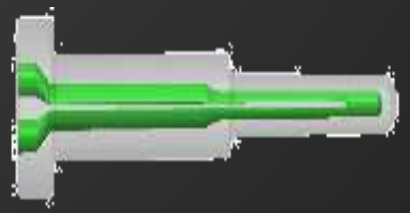


Conformal cooling inserts



Zero Sink &
eliminated buffing

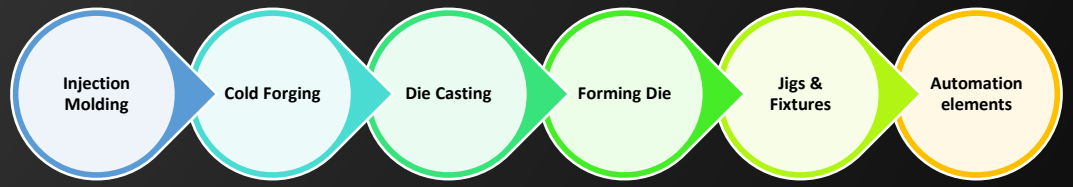
Zero Sink &
distortion minimized
Coining eliminated



Zero Sink & chip-off
eliminated

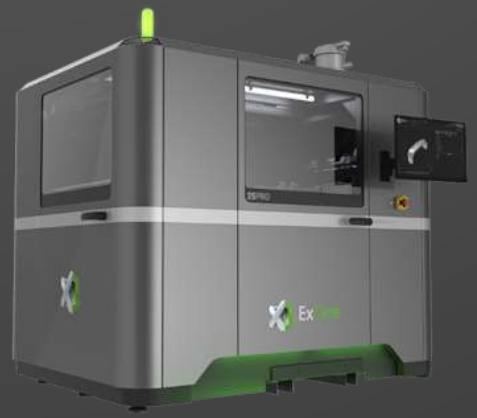
BJT – M2 GRADE MOLD / TOOL INSERTS

- INDO-MIM manufactures M2 tool inserts for tooling industry
- BJT printed M2 grade inserts have an excellent martensitic microstructure with fine grains
- BJT inserts have an excellent machinability even with the HT condition
- 50% increase in the wear resistance
- 30% ~ 50% increase in the tool life (# of shots)
- Near net shape allows faster finish machining
- Inserts come with the customized conformal cooling design
- BJT M2 inserts fits a wide variety of tooling applications



BJT – PRINTERS AT A GLANCE

- Ex One Innovent+
- 65 X 160 X 65 mm



- Ex One 25PRO
- 400 X 250 X 250 mm

- HP Metal Jet S100
- 430 X 309 X 140mm

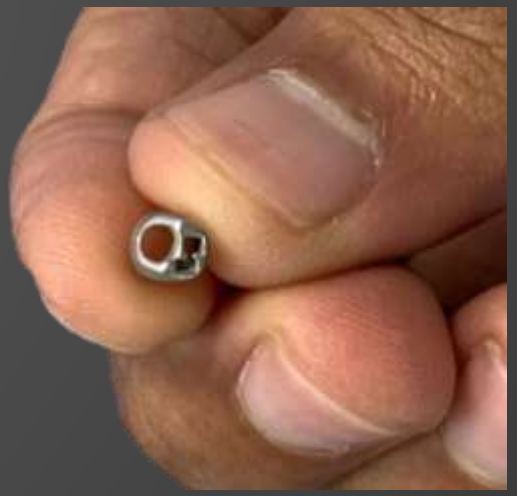
Material options

SS 17-4PH, SS 316, HK-30, M2, S7, H13, S7, 4605, 4140, SS 420, In 718, In 625

LMM PROCESS

LMM – PROCESS

- Incus Hammer Lab 35
- 56 x 89 x 120 mm (build box)
- SS 316, SS17-4 PH



- Surface Ra 2 µm after Sintering
- Ra ~ 0.8 by post processing
- Wall thickness as low as 0.2 mm
- Weight of the part as low as 0.5 g
- Tolerance capability ± 2 % of Nominal
- Density 98%
- Suitable for Medical & Jewellery applications
- Complex & intricate profiles possible

LMM – TOLERANCE CAPABILITIES

INDO-MIM® COMPLEXITY SIMPLIFIED

Process	Lithography based Metal Mfg (LMM)		
Printers available	Model	Build Box Dimensions (mm)	
INCUS	LAB 35	56 X 89 X 120 (Z)	
INCUS (to be installed in 2025)	Hammer 35	250 X 153 X 150 (Z)	
Material Options (Current)	SS 17-4PH	SS 316L	Tool Steel M2
As sintered density	98%	98%	99.50%
Material Hardness range post-heatment (based on heat treatment process)	30~42 HRC	~ 70 HRB	55~64 HRC
Material properties	Can be shared upon request		
Minimum wall thickness	0.15 mm (Aspect ratio can influence this)		
Maximum wall thickness	~ 10 mm		
Weight Range	0.05 ~ 10 grams		
Maximum part foot print	Based on the build box dimension available		
Surface finish based on layer thickness for printing	20 microns layer	50 microns layer	Surface finish in Z direction will be rougher
	2~4 Ra	5~7 Ra	
Flatness	Depends upon product configuration and wall thickness		
Dimensional tolerance	±1% of the feature size		
Minimum resolution	0.15 mm (0.006") minimum (resolution in Z direction 0.3 mm)		
Suitable production volume (0.05~5 grams)	10~50,000+ parts/yr per Printer		
Suitable production volume (5~10 grams)	10~10,000 parts/yr per printer		
Secondray finishing offered	CNC turning/ milling, surface grinding ,surface finishing, heat treatment etc.		
Design assistance	Offered through detailed DFAM		
Service locations	Bangalore, India		
Typical leadtime for sample shipment	~ 2 weeks for simple projects, 3~5 weeks for complex projects		
RFQ response time	24~72 hours for simple projects, ~ 10 days for complex projects		

LMM – APPLICATION EXAMPLES

INDO-MIM®
COMPLEXITY SIMPLIFIED





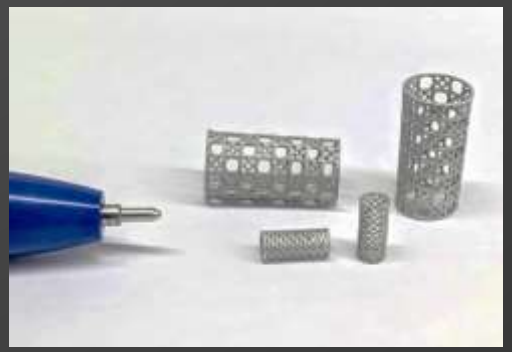












Material options

SS 17-4PH, SS 316, M2, Copper, Ti-6Al-4V

LPBF PROCESS

LPBF – PROCESS

SLM SOLUTIONS

- SLM 280
- 280 X 280 X 365mm

- Intech iFusion SF-1
- Ø150 X 180mm

Material options

SS 17-4PH, SS 316, HK-30, M2, Maraging steel, Inc 718, Inc 625, CoCr (F75)

LPBF – TOLERANCE CAPABILITIES

INDO-MIM® COMPLEXITY SIMPLIFIED

FEATURES	CURRENT CAPABILITY
Tolerance (upto 40 mm)	± 0.1 mm
Surface finish (as sintered)	6 ~ 14 Ra
Minimum wall thickness	0.3 ~ 0.4 mm
Maximum wall thickness	50 mm
Weight range	10g ~ 10 Kgs

Process	Laser powder bed fusion (LPBF)		
Printers available	Model	Build Box Dimensions (mm)	
Intech	SF1	Ø 150 X 180 (Z)	
SLM -NIKON	SLM 280	280 X 280 X 365 (Z)	
SLM -NIKON	SLM 500	400 X 250 X 250 (Z)	
Material Options (Current)	SS 17-4PH	SS 316L	Inc 625
	Inc 718	CoCr(F75)	Maraging Steel
Typical density	99.5 % minimum		
Material Hardness range post-heatment (based on heat treatment process)	Depends on the material and heat treatment process		
Material properties	Can be shared upon request		
Minimum wall thickness based on asepct ratio	< 10 mm length	Aspect ratio 1:10	Aspect ratio 1:30
	0.30 mm	0.30 mm~ 3.0 mm	>3 mm
Maximum wall thickness	~ 50+ mm (2.0")		
Weight Range	10 grams to 10+ Kgs		
Maximum part foot print	Based on the build box dimension available		
Surface finish based on layer thickness for printing	30 microns layer	60 microns layer	Surface finish in Z direction will be rougher
	6~10 Ra	8~14 Ra	
Flatness	Depends upon product configuration and wall thickness		
Dimensional tolerance	upto 5 mm length	5~40 mm length	Beyond 40 mm length
	0.05 mm	± 0.10 mm	As per DIN ISO 2768
Minimum resolution	0.20 mm (0.008") minimum (resolution in Z direction 0.40 mm)		
Suitable production volume (10~30 grams)	10~100,000+ parts/yr per Printer		
Suitable production volume (30~1000 grams)	10~5,000 parts/yr per printer		
Secondray finishing offered	CNC turning/ milling, surface grinding ,surface finishing, heat treatment etc.		
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ADDITIVE MANUFACTURING VS CONVENTIONAL

INDO-MIM®
COMPLEXITY SIMPLIFIED

- No need of Tooling investment (as in case of MIM/IC)
- Volumes can be LOW to MEDIUM
- Shorter lead time (2 ~ 4 weeks)
- Variety of material choices with the same part design
- Complex geometry can be obtained
- No limitation to the undercut geometries
- Material properties equal to MIM
- Meeting the drawing specification by post processing
- Freedom of multiple design iterations @ customer end
- Fully finished supplies from Indo-MIM (incl surface finishing processes)

MORE THAN 4000 HEARTS – ONE BEAT

Creating Value :

- In-depth technical competence
- International presence
- Application and Industry Expertise
- Long-term Relationships

THANK YOU

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