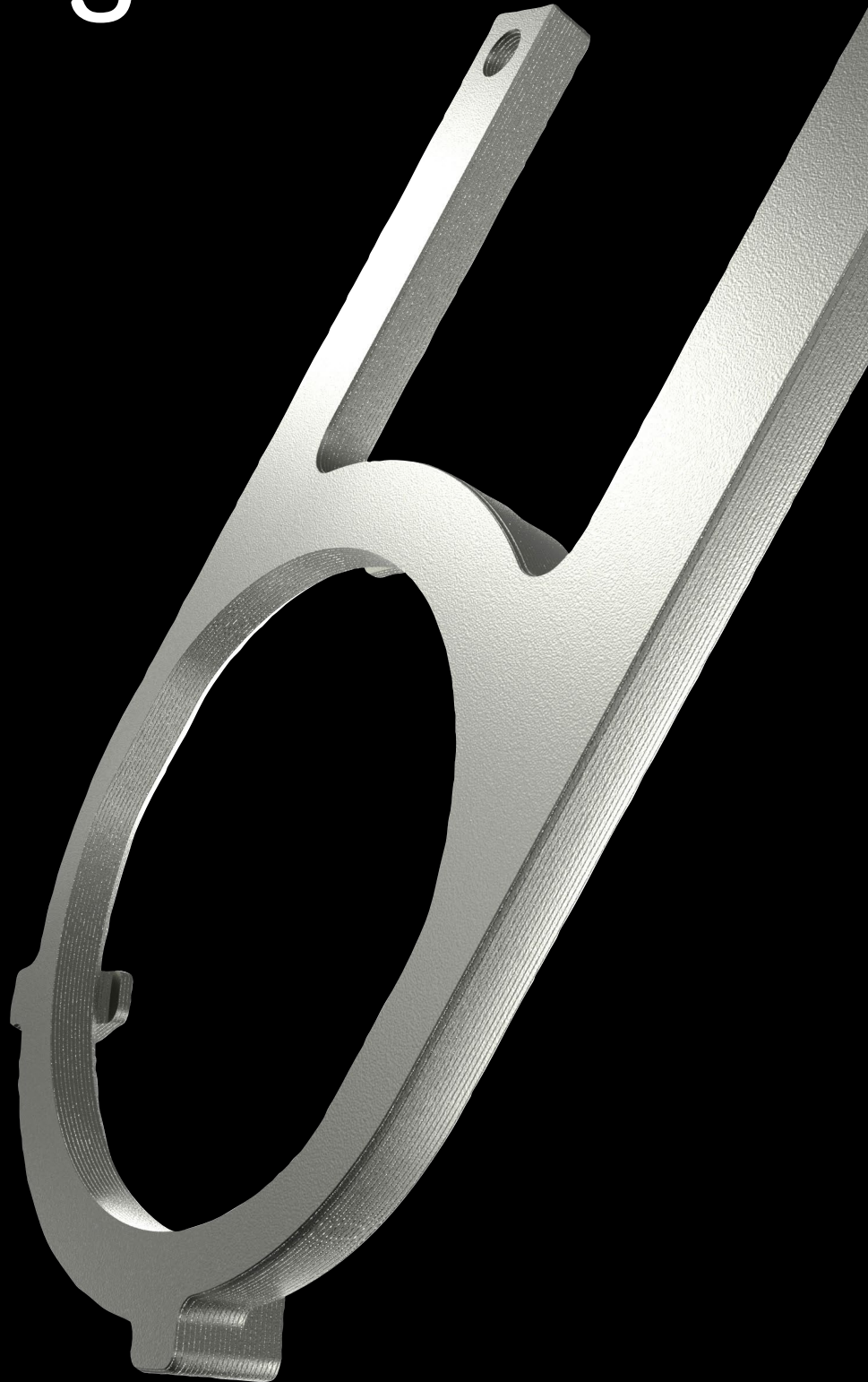


# Metal 3D Printing



# Metal X

The Metal X significantly accelerates your innovation and delivers metal components overnight. Forget 20th century manufacturing and print everything such as industrial spare parts, injection moulds and working prototypes.

The Metal X is based on a new innovative technology: Atomic Diffusion Additive Manufacturing or ADAM for short.

The printing material consists of a metal powder in very high concentration bound in plastic. It is printed using the proven FFF process - completely without toxic metal dust. This is followed by a debinding and sintering process and the result is a metal part created overnight. The sintering process causes atomic diffusion: due to the heat, the atoms shift slightly and stick together. As a result, the components achieve excellent mechanical properties and enormous rigid-ity even in the z-direction.

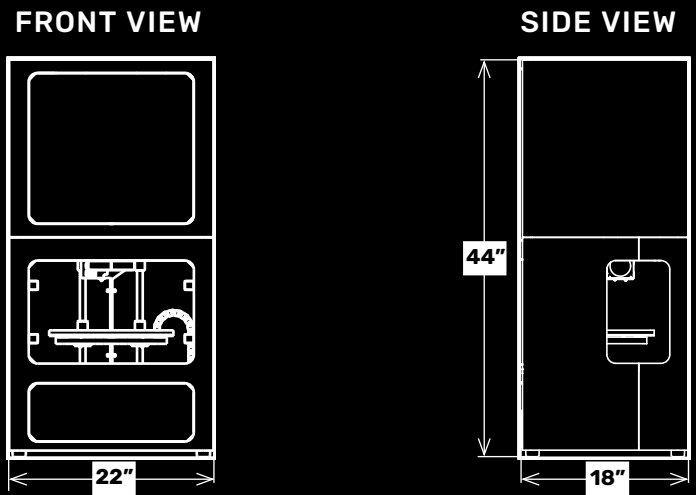


PRODUCT SPECIFICATIONS

Metal X

The Metal X is a revolutionary 3D printer that prints metal powder bound in a plastic matrix to eliminate safety risks associated with traditional metal 3D printing methods while enabling new features like close-cell infill for reduced part weight and cost. It’s up to 10x less expensive than alternative metal additive manufacturing technologies and up to 100x less than traditional fabrication technologies like machining or casting. Affordable, reliable, and easy to use, the Metal X print system gives you everything you need to go from design to fully functional metal parts faster than ever before.

Printer Properties	Process	Atomic Diffusion Additive Manufacturing (ADAM)
	Build Volume	300 x 220 x 180 mm (11.8 x 8.7 x 7.1 in)
	Machine Size	575 x 467 x 1,120 mm (22.7 x 18.4 x 44.1 in), 75 kg (160 lbs)
	Print Chamber	Heated
	Print Bed	Heated, vacuum-sealed print sheet, auto bed leveling
	Print System	Two nozzles – Metal material and release material
	Power Requirements	100–120 / 200–240 VAC (12A / 6A), IEC 60320 type C20
Materials	Metal Material	Stainless steel (17–4 PH, 316L*), Tool steel (H13, D2), Inconel 625, Copper
	Release Material	Ceramic (consumed at 1:10 ratio to metal spools, on average)
	Media (Spools)	Filament fed, bound powder
Part Properties	Max Part Size	250 x 183 x 150 mm (9.8 x 7.2 x 5.9 in), 10kg
	Supports	Metal material with ceramic release layer
	Layer Height	50µm and 125µm post-sinter
Software	Supplied Software	Eiger Cloud (Other options available at cost)
	Security	Two-factor authentication, org admin access, single sign-on



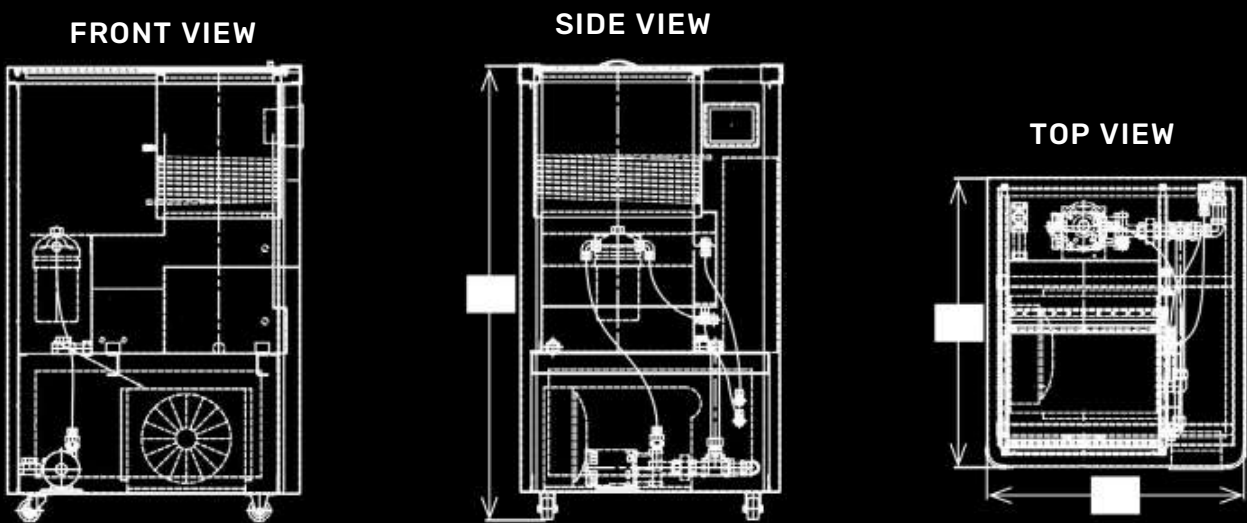
\* Materials currently under development. Note: All specifications are approximate and subject to change without notice.

PRODUCT SPECIFICATIONS

Wash-1

The first step in transforming a printed “green” part into fully dense metal is debinding. The Wash-1 immerses the green part in a specialized fluid which dissolves the primary binding material, leaving the part semi-porous so the remaining binder can easily burn off during sintering. This debinding step purifies the final metal part and helps keep your sintering furnace clean.

Debinder Properties	Materials Supported	All metals
	Fluid (Solvent)	Opteon SF79, Opteon SF80, or Tergo Metal Cleaning Fluid
	Controller	Integrated control system
	Workholding	Stainless steel basket
	Washing Size	356 x 254 x 203 mm (14 x 10 x 8 in)
	Washing Size	18,356 cm³ (1,120 in³)
Safety & Installation	Environmental Req.	External exhaust
	Safety Control	Low fluid shutoff control High vapor pressure shutoff control
	Regulatory	Refer to MSDS
	Emissions	Low emission design to conserve solvent
	Power	110-120 VAC single phase, 11A / 1,320W peak draw
Safety & Installation	External Dimensions	609 x 685 x 1,067 mm (24 x 27 x 42 in)
	Weight	136 kg (300 lbs)



Note: All specifications are approximate and subject to change without notice.

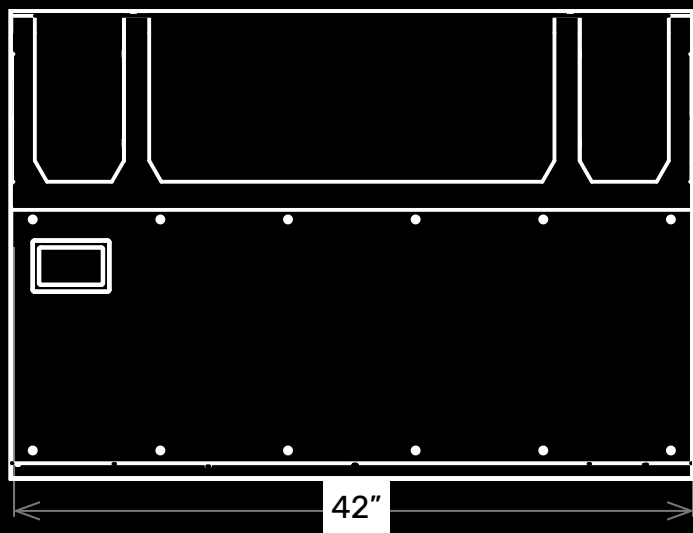
PRODUCT SPECIFICATIONS

Sinter-1

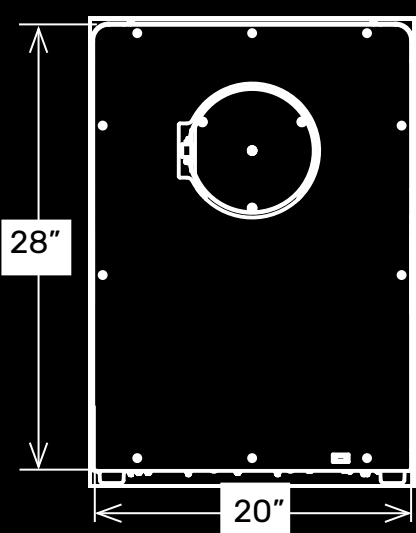
The Markforged Sinter-1 is a high-performing, high-value furnace that is ideal for small batch production. Built on 30 years of Metal Injection Molding (MIM) technology, it’s affordable and reliable. Featuring 4,760 cm3 of active hot zone, the Sinter-1 effortlessly converts washed parts into their high-quality dense final metallic form in as few as 26 hours.

Furnace Properties	Materials Supported	Chemically debound Metal X-printed parts
	Heating Element	Kanthal
	Controller	Pre-programmed automatic cycling
	Sinter Run Time	26 hours*
	Peak Internal Temp.	1,300° C / 2,372° F
	Sintering Capacity	Rectangle w/radius top – 141 mm ID x 305 mm L (5.55 in ID x 12 in L)
	Sintering Workload	3,020 cm3 (184 in3)
	Sinter Surface Area	348 cm2 (53.9 in2) for single ceramic setter plate
	Setter Plate Dimensions	11.4cm W x 30.4cm D, (4.5in W x 12.0in D)
	Gas Types	Argon, argon / hydrogen mix
Safety & Installation	Retort	High purity refractory retort (carbon-free)
	Environmental Req.	External exhaust (100–150 CFM)
	Power	200–240 V single phase 30A, recommend wiring 50A
	External Dimensions	1,270 x 510 x 720 mm (50 x 20 x 28 in)
	Weight	136 kg (300 lbs)

FRONT VIEW



SIDE VIEW



\*May vary by material. Note: All specifications are approximate and subject to change without notice.

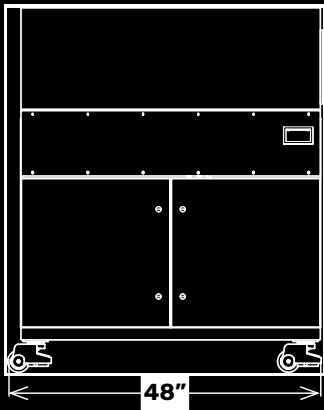
PRODUCT SPECIFICATIONS

Sinter-2

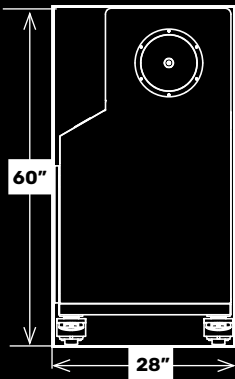
With an expansive active hot zone (19,644 cm<sup>3</sup> / 1,199 in<sup>3</sup>), the Sinter-2 is the perfect solution for mid-volume batch production and for larger parts. Create high-purity metal parts by using sintering technology built with a carbon-free retort. This workhorse furnace is enabled with rapid cooling technology and can process the full range of commercial-grade metals from their washed state into dense metal parts in as few as 30 hours.

Furnace Properties	Materials Supported	Chemically debound Metal X-printed parts
	Heating Element	Kanthal
	Controller	Pre-programmed automatic cycling
	Sinter Run Time	30 hours*
	Peak Internal Temp.	1,300° C / 2,372° F
	Sintering Capacity	Rectangle w/radius top – 141 mm ID x 305 mm L (5.55 in ID x 12 in L)
	Sintering Workload	12,135 cm <sup>3</sup> (741 in <sup>3</sup> )
	Sinter Surface Area	1,644 cm <sup>2</sup> (254.8 in <sup>2</sup> ) for stackable ceramic setter plate
	Setter Plate Dimensions	Top plate: 24.0cm W x 41.0cm D, (9.4in W x 16.1in D) Bottom plate: 17.0cm W x 41.0cm D, (6.7in W x 16.1in D)
	Gas Types	Argon, argon / hydrogen mix
Retort		High purity refractory retort (carbon-free)
Safety & Installation	Environmental Req.	External exhaust (100–150 CFM)
	Power	200–240 V, 3 phase (3 wire), 30 A 346–416 V, 3 phase (4 wire), 30 A
Physical Dimensions	External Dimensions	1,370 x 810 x 1,520 mm (54 x 32 x 60 in)
	Weight	350 kg (772 lbs)

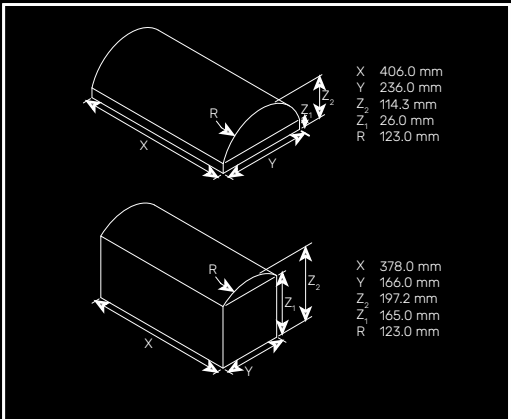
FRONT VIEW



SIDE VIEW



MAX SINTER VOLUME



\*May vary by material. Note: All specifications are approximate and subject to change without notice.

# Success Plan

Print high-quality parts easily and reliably with Markforged 3D Printers. Secure yourself against wear and accidental damage with the success plan.

For 3 Years	Metal X with Washing Station and Sinter Furnace 1	Metal X with Washing Station and Sinter Furnace 2
Price	AED 125,000	AED 150,000
Cover of wear and tear accidental damage	✓	✓
On-site repair*	✓	✓
Free same day priority support (phone or email)	✓	✓

For 5 Years	Metal X with Washing Station and Sinter Furnace 1	Metal X with Washing Station and Sinter Furnace 2
Price	AED 200,000	AED 225,000
Cover of wear and tear accidental damage	✓	✓
On-site repair*	✓	✓
Free same day priority support (phone or email)	✓	✓

For 1 Year Renewal	Metal X with Washing Station and Sinter Furnace 1	Metal X with Washing Station and Sinter Furnace 2
Price	AED 55,000	AED 65,000
Cover of wear and tear accidental damage	✓	✓
On-site repair*	✓	✓
Free same day priority support (phone or email)	✓	✓



# Metal X printing material

## 1.4542 (17-4 PH) Stainless Steel

17-4 PH Stainless steel is ideal for post-processing in CNC milling and turning and is resistant to corrosion up to 800°C. For example, it is also used for the drive roller for the fibre system on the X series.

## 1.2379 (D2) Tool Steel

The high carbon and chromium content of D2 tool steel provides excellent hardness and abrasion resistance (but not as hard as A2). D2 is often used for cutting tools.

## 1.2344 (H13) Tool Steel

Tool steel H13 is air-hardened and has excellent impact strength. It is used for punches, dies and forming tools. The high carbon and chromium content of 1.2344 tool steel guarantees enormous hardness and abrasion resistance. H13 tool steel is often used for cutting tools.

## 1.2363 (A2) Tool Steel

Tool steel A2 is a versatile, air-hardening tool steel that is often regarded as a "universal" cold work tool steel. It offers a combination of good wear resistance and toughness. It is relatively easy to machine in the annealed condition, has high compressive strength and good dimensional stability during hardening. It is used for a wide range of tools, from forming and cutting equipment to wear parts.

## IN Alloy (Inconel 625) 1.7744

Inconel combines stability with enormous heat resistance. This makes it ideal for heat protection and high pressure applications. This nickel alloy is commonly used in engines and medical applications. It is also chemically resistant and difficult to machine.

## Copper

99.8% pure copper from Markforged has excellent thermal and electrical conductivity.





# Material Specification – Metals

	Norm	17-4	17-4 (HT <sup>1</sup> )	H13	H13 (HT <sup>2</sup> )	Copper
Ultimate Tensile Strength (MPa)	ASTM E8	1050	1250	1420	1500	193 <sup>5</sup>
Tensile Modulus (GPa)	ASTM E8	140	170	-	-	-
Yield Strength (MPa)	ASTM E8	800	1100	800	1250	26 <sup>5</sup>
Elongation at Break (%)	ASTM E8	5	6	5	5	45 <sup>5</sup>
Compressive Yield Strength (MPa)	ASTM E9	-	-	-	-	-
Elastic Modulus (GPa)	ASTM E9	-	-	-	-	-
Hardness (HRC)*	ASTM E18	30	36	40	45	-
Relative Density (%)	ASTM B923	>96	≥96	≥ 94,5	≥ 94,5	98 <sup>6</sup>
Electrical Conductivity (% IACS)	ASTM E1004	-	-	-	-	84 <sup>7</sup>
Thermal Conductivity (W/mK)	ASTM E1461	-	-	-	-	350 <sup>8</sup>

	Norm	A2	A2 (HT3)	D2	D2 (HT4)	Inconel 625
Ultimate Tensile Strength (MPa)	ASTM E8	-	-	-	-	765
Tensile Modulus (GPa)	ASTM E8	-	-	-	-	-
Yield Strength (MPa)	ASTM E8	-	-	-	-	334
Elongation at Break (%)	ASTM E8	-	-	-	-	42
Compressive Yield Strength (MPa)	ASTM E9	850	-	830	1690	-
Elastic Modulus (GPa)	ASTM E9	180	180	170	187	-
Hardness (HRC)*	ASTM E18	52	58	54	60	7
Relative Density [%]	ASTM B923	≥ 94,5	≥ 94,5	97	97	96,59
Electrical Conductivity (% IACS)	ASTM E1004	-	-	-	-	-
Thermal Conductivity (W/mK)	ASTM E1461	-	-	-	-	-

\* Markforged hardness was measured on a sample coupon that was printed at 100% infill and has a 25 mm diameter and 10 mm height.

1. 17-4 PH MIM standard stainless steel heat treated to H900 specification.

2. H13 Tool Steel printed with the Metal X system, air quenched at 1010C, and double tempered at 600°C.

3. Markforged heat-treated A2 tool steel was heated to 970°C (1780°F) and single tempered at 200°C (392°F) for 30 minutes.

4. Markforged heat-treated D2 tool steel was heated to 970°C (1780°F) and single tempered at 200°C (392°F) for 30 minutes.

5. Tensile bars are sub-sized and are sliced with default copper settings except raft is turned off. Copper defaults to solid parts.

6. Density is based on a theoretical value of 8.96g/cc.

7. Electrical conductivity, when evaluated with eddy current instruments, is usually expressed as a percentage of the conductivity of the International Annealed Copper Standard [% IACS]. The conductivity of the Annealed Copper Standard is defined to be 0.58 x 10<sup>8</sup> S/m (100% IACS) at 20°C.

8. Thermal diffusivity measured per ASTM E1461. Diffusivity was converted to Conductivity using, Thermal Conductivity = Thermal Diffusivity Density Specific Heat.

Assuming specific heat of Copper = 0.385 J/g-K per "Handbook of Chemistry and Physics 72nd Edition."

9. Relative density for Inconel 625 assumes a reference density of 8.44 g/cm<sup>3</sup>.

These data for Markforged Materials represent typical values as-sintered. Markforged samples were printed as fully dense parts with 100% infill. Hardness and density data were tested in house, and all other data were tested and confirmed by outside sources. These representative data were tested, measured, or calculated using standard methods and are subject to change without notice. Markforged makes no warranties of any kind, express or implied, including, but not limited to, the warranties of merchantability, fitness for a particular use, or warranty against patent infringement; and assumes no liability in connection with the use of this information. The data listed here should not be used to establish design, quality control, or specification limits, and are not intended to substitute for your own testing to determine suitability for your particular application. Nothing in this sheet is to be construed as a license to operate under or a recommendation to infringe upon any intellectual property right.

## **EIGER Software\*: Powerful. Flexible. Secure.**

With Markforged's high strength and com-posite fibre printers, we deliver the innovative, smart EIGER software compatible with all our printers.

### **Powerful**

The strength of Markforged printers is the stability of the part and the precise surface finish. EIGER software makes it easy to increase sub-stability with our unique Continuous Fibre Reinforcement. In addition, EIGER offers the possibility of accessing and managing all printers and print jobs with just one program.

### **Achieve 10-fold stability with just one click**

EIGER adds selected fibre reinforcement to your component. Simply select the option "Use fibre". You retain full access to the pro-cess and can intervene at desired points and make manual adjustments.managing all printers and print jobs with just one program.

### **Continuous improvement**

Cloud-based, EIGER always provides the latest version. Once a new update has been deployed, it will be displayed the next time you log in to EIGER. Large files can easily be processed in the background, while you can continue working in other programs.

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### **Control all printers from one place**

With EIGER you can easily access all your organization's printers and print files. Whether you use one or a hundred print-ers, our networked system collects all data clearly arranged in one place.

Each printer from Markforged can be con-nected via Ethernet or WiFi. Distances do not matter. You will receive important sta-tus messages by e-mail and, for example, be informed in good time about low material stocks and completed print jobs.



### **User-friendly**

To print the most stable parts, you do not need any special training. Simply upload and slice your STL file into EIGER for a high strength part.

### **Data is never lost**

Projects can be created in EIGER. There you can organize your print files, find them quickly and reuse or revise them. Since everything is stored in the cloud, your files will be kept in case of a computer crash. The version history can also be used to restore accidentally overwritten files.

### **Intuitive user interface**

Our software regulates all temperature, speed and monitoring settings to optimize print performance and reduce the user's workload.

### **Collaboration**

EIGER works organizationally. Each team member can get access to the program. This allows files to be shared, discussed, edited and improved with colleagues even across distances.

\*The services described here refer to the Eiger Cloud Software.

Markforged takes the security and privacy of your data very seriously.



## ISO 27001 Safety certification

- Markforged is the only certified manufacturer in the additive field.
- The certification has been awarded by an external test centre.
- Your data is safe in the EIGER software!

### EIGER Software Cloud Online Version

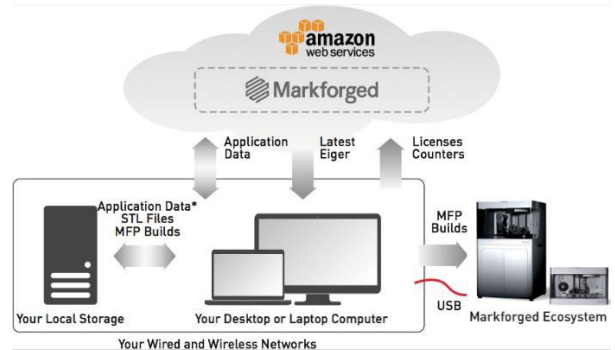
Only users of your organization can access your data. We take the best precautions, including SSL/TLS encryption of any communication with our servers, external backups of user data, and Amazon Web Services (AWS), which preserves the data for us.

Any communication with Markforged is encrypted.



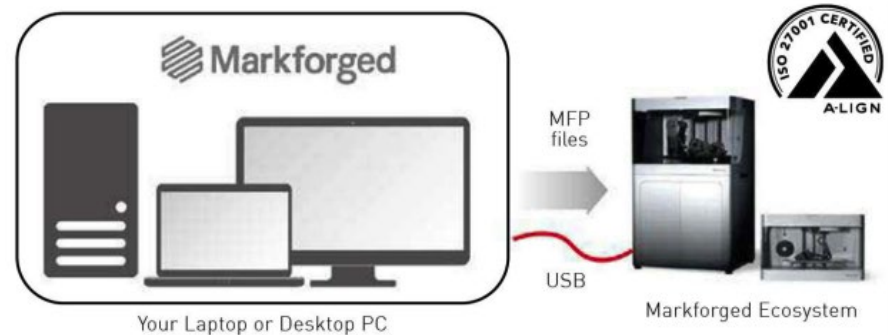
### EIGER Software Desktop Online Version

For even greater security we offer an internally storable version from EIGER at no additional cost. The user stores his STL files, the internal slice data and MFP files 100% locally on his hard disk. A permanent internet connection is required for application data, software updates, license verification.



### Optional: EIGER Soft-ware Offline Version

In special cases we provide a limited version of EIGER off-line for an additional fee.



\*In the EIGER Software Desktop online version, your STL files, generated print files or specific geometrical information about your component will not be sent to our servers. We slice to local printing on your machine. Telemetry data sent to the server includes account information for the license server, folder structures, printer settings and used quantities of material/print volumes. These data are covered by the Markforged Privacy Policy.

MFP (Markforged Print) files are the raw output of EIGER software that the Markforged printers use to print the part. Currently the printer can only be connected to the corporate network via a USB device server. To use the cloud version Google Chrome is required. The status of the printer can be viewed as soon as the printer has an Internet connection.



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