Accelerating Industrial Additive Manufacturing

Additive Industries

MetalFAB1
Industrial Additive Manufacturing System

Contents

Additive Industries

Established in 2012 in the “Brainport Ecostructure” around Eindhoven in The Netherlands, Additive Industries is the world’s first dedicated equipment manufacturer for industrial metal additive manufacturing systems. Built on the high tech systems, optics and electronics heritage of this region, founders Jonas Wintermans and Daan Kersten have created a company of talented professionals committed to industrialising 3D printing using ‘open innovation’ principles to capitalise on proven technology. By putting the customer first in everything we do, we enable them to improve their designs, product performance and business cases for the best competitive position in their market.

From its headquarters in The Netherlands, Additive Industries is building a global network to best serve local customers. Research & development and system integration as well as software development are done centrally in Eindhoven, while the activities closest to the customer are executed from regional Process & Application Development Centers and Service & Support hubs in the United Kingdom, North America and Singapore.


Additive Industries
Process & Application Development Center
Bristol, UK
Additive Industries North America Inc.
Service & Support Center
Detroit, Michigan, United States
Additive Industries
Headquarters
Eindhoven, The Netherlands
Additive Industries North America Inc.
Process & Application Development Center
Los Angeles, California, United States
Additive Industries Asia Pacific
Process & Application Development Center
Singapore

Accelerating Industrial Additive Manufacturing

Additive Industries is accelerating industrial additive manufacturing of high quality, functional, metal parts by offering a modular, end-to-end laser powder bed fusion system, MetalFAB1, and seamlessly integrated information platform, Additive World Platform, to high end and demanding industrial markets. With substantially improved reproducibility, productivity, and flexibility, Additive Industries redefines the business case for series production of additive manufacturing applications in aerospace, automotive, medical technology, tooling and high-tech equipment.

MetalFAB1

Industrial Additive Manufacturing System

MetalFAB1 is the first integrated metal additive manufacturing system designed for high end industrial applications in demanding markets like aerospace, medical, high tech equipment, tooling and automotive.

MetalFAB1 Family

Productivity leadership through integration and automation

MetalFAB1 was developed by a team of experienced high tech equipment engineers. Open innovation has led to a new and distinctive system architecture based on well-proven concepts and efficient application of matured functional building blocks from robotics, lithography and other opto-mechatronical systems.

For industrial-quality production with additive manufacturing technology, the reproducibility of the core powder bed fusion is assured by solid machine design in combination with advanced calibration technology and feedback control algorithms. Predictability is achieved by combining simulation and in-process quality monitoring with the additive manufacturing (AM) process. When a system is equipped with two or more additive manufacturing core modules, productivity is up to ten times higher than typical midrange systems and multiple materials are possible without running the risk of cross-contamination.

For world class performance, operations in the metal additive manufacturing process flow need to work seamlessly together. Multiple process steps are combined in one machine using automated handling to reduce manual labour, improve product conformity and quality as well as increasing operator safety. The modular MetalFAB1 architecture ensures maximum flexibility and allows the user to define custom configurations from 3 to 11 modules and add additional lasers and optics as future productivity needs dictate.

MetalFAB1

Industrial Additive Manufacturing System

Industrial grade specifications

The MetalFAB1 system specifications are founded on a comprehensive system design process, defining the system architecture, modules, interfaces and controls to meet demanding customer requirements. An on-going dialogue with our customers feeds the technology roadmap for continuous improvement.

MetalFAB1 System Specifications*

Process type:	Laser Beam Powder Bed Fusion
Net build envelope:	420 x 420 x 400 [mm] (16.5 x 16.5 x 15.7 [In])
Laser:	Yb fibre lasers 500W (1 [kW] under development)
Number of Lasers:	1 to 4 full field, preventing laser overlap regions
Configurability:	Configure 3 up to 11 modules for more productivity or post-processing automation
Build plate:	Automated levelling and positioning
Powder handling:	Automated extraction, sieving and recycling during the build cycle
Autonomous operation:	112 [hrs], maximum 8 build jobs
Productivity:	Up to 1.000 dm3/yr (with 4 lasers, depending on material)
Accuracy:	< |0.050 + 0.002 x part length| [mm]
Reproducibility:	< |0.050| [mm]
Layer Thickness:	20-100 µm
Optical calibrations:	In-line, automated, laser-2-laser and focus
Safety:	No direct powder exposure during regular operations
Storage positions:	8 empty build plates
Job preparation:	Off line build set up, Dynamic Laser Assignment
Remote access & monitoring:	Yes, through Additive World Platform
Materials	Titanium (Ti6Al4V), Aluminium (AlSi10Mg), ScalmAlloy©, Stainless Steel (316L), Inconel (IN718), Tool Steel (1.2709)
Preheating	175 °C

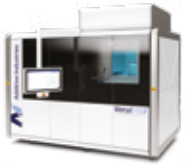
** Specifications may change*

MetalFAB1
Industrial Additive Manufacturing System

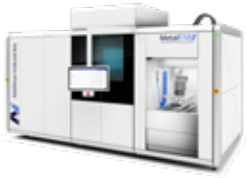
Configurations for various applications

Additive Industries offers a range of metal powder bed fusion systems based on application specific modular building blocks. The smallest footprint is a two module version developed specifically for process and application development, low-rate initial production or large build workflows requiring no automation. This configuration can be upgraded to a fully automated and integrated production additive manufacturing system with multiple materials, including post-processing functions such as heat treatment and build plate storage. With up to four lasers that can scan the entire build platform and a net build volume of 420 x 420 x 400 [mm], the MetalFAB1 system offers unmatched productivity.

Process & Application
Development, Prototyping

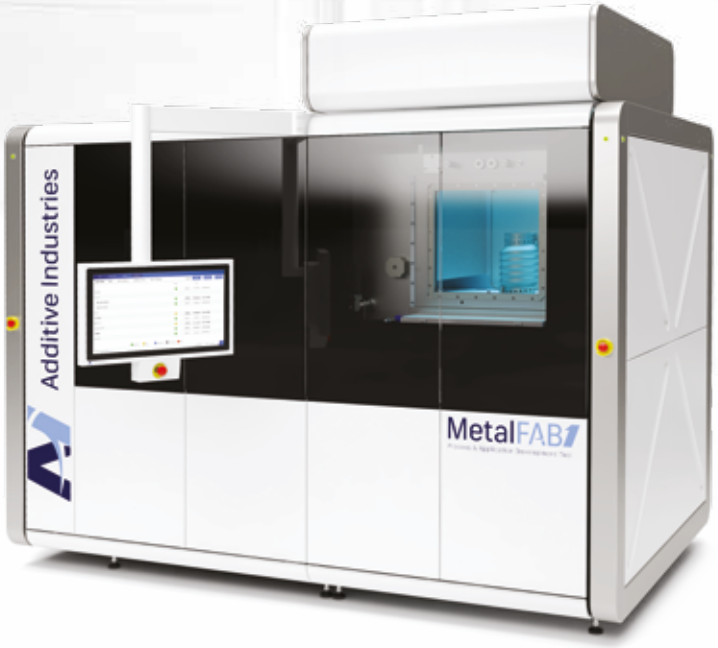


Small series
Full automation



Larger capacity, Multiple materials
Additional functionality

- Build volume: 420 x 420 x 400 [mm], exchangeable
- Lasers and optics: 1-4x 500 [W], all full field (1 [kW] under development)
- Calibration strategies: focus, X-Y, laser-2-laser
- Future proof: open platform, upgradable, modular expandable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MetalFAB1

MetalFAB1
Industrial Additive Manufacturing System

Process & Application Development, Prototyping

The smallest footprint and, therefore, lowest cost member of the MetalFAB1 family is the Process & Application Development system. It is designed specifically for new users of the metal additive manufacturing technology, as well as experienced process & application development departments, prototyping use or large build volume jobs. Although it is configured with two modules (see section 'MetalFAB1 Modules explained' for full description of the modules and its functionality), it has most MetalFAB1 powder bed fusion features and functionality like 420 x 420 x 400 [mm] build volume, 1-4 full field lasers and fully automated powder handling and extraction (in continuous inert conditions for limited material degradation).

The modular architecture of the MetalFAB1 makes the Process & Application Development system a future-proof investment since it can be upgraded to improve productivity later with additional lasers, more material types (extra AM Core Modules) and additional functional modules for process automation and reduced powder exposure (Exchange Module, Storage Module) as well as post processing (Heat Treatment). Since the powder bed fusion process doesn't change with upgrades, part and process qualification is easier as production scales up.

Typical use:

- Process and application development
- Part qualification
- Low rate initial production
- Large parts with limited manual labour

Configuration:

- Controls Module
- Additive Manufacturing Core (AM Core)
- Exposure Module (1 laser, can be upgraded to 2, 3 or 4 lasers)
- Human Machine Interface (HMI)


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MetalFAB1

MetalFAB1

Industrial Additive Manufacturing System

Small Series, Full Automation

The entry-level production version of the MetalFAB1 family is the MetalFAB1 three module. This powder bed fusion system is developed for fully automated and safe production of single large parts or small series production. The Exchange Module and Robot automate all build plate and finished product handling, thus eliminating operator labour and preventing direct contact with metal powders during regular production. Moreover, system and laser calibration can be done automatically between build jobs for the highest reproducibility and productivity.

This MetalFAB1 system can also be equipped with additional lasers for faster production rates of large parts, a second AM Core Module for increased productivity, autonomous job changes, extra modules for new materials (AM Core Modules) and post-processing (Storage and Heat Treatment).

Typical use:

- Single large part production
- Small and mixed series production
- Large parts (in 420 x 420 x 400 [mm] or 16.5 x 16.5 x 15.7 [In] build volume)

Configuration:

- Controls Module
- Additive Manufacturing Core (AM Core)
- Exposure Module (1-4 lasers)
- Human Machine Interface (HMI)
- Robot
- Exchange Module


Additive Industries
MetalFAB1

MetalFAB1
Industrial Additive Manufacturing System

Larger Capacity, Multiple Materials, Additional Functionality

Starting with a three module MetalFAB1 (see description on previous page), the MetalFAB1 can be extended to a fully integrated high productivity metal additive manufacturing system. This MetalFAB1 is configured to the typical components the user will manufacture. For the lowest total cost per part, the MetalFAB1 contains four lasers and at least two Additive Manufacturing Cores for continuous printing. While in one AM Core a job is being executed, the other can be used for automated powder extraction, build plate exchange, inerting as well as (preventive) maintenance. This increases the manufacturing time and efficiency of the system. Integration of thermal post processing increases the reproducibility, reduces manual labour, in addition to removing the need for separate equipment. Process qualification is also made easier with integrated heat treatment. The Storage Module, which holds up to eight new build plates, allows the system to be operated 24/7 with only a single shift since the system can automatically start a new build job from the build queue.

The exact configuration of the MetalFAB1 is based on a detailed calculation of the total cost and a comprehensive business case by the Additive Industries Process & Application Development team.

Typical use:

- Mixed material small batch manufacturing
- Production of various part families
- Larger series of small and medium size single material parts

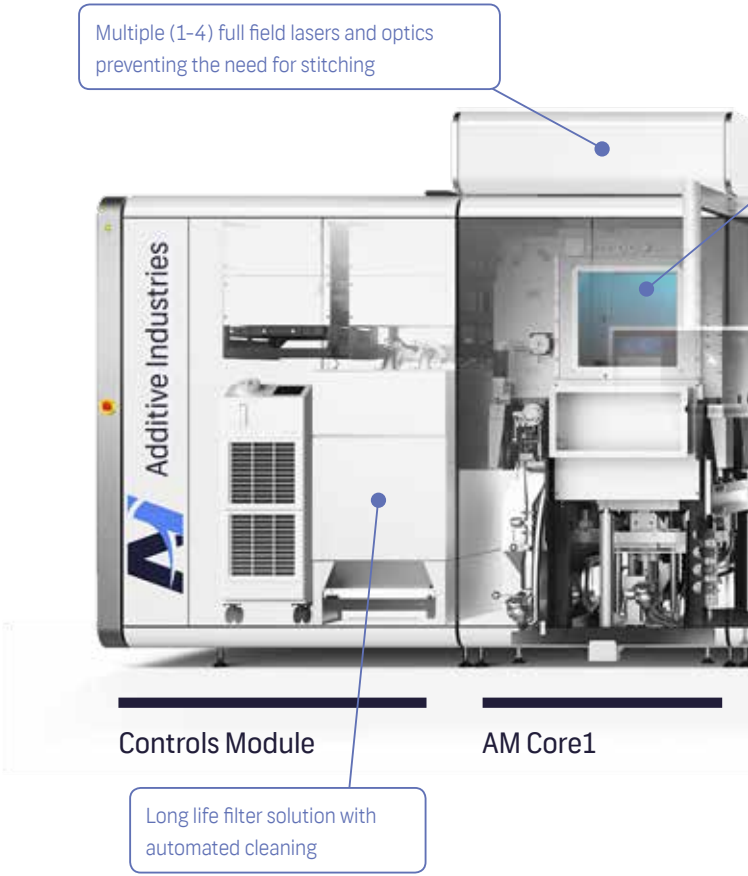
Configuration:

- Controls Module
- 2-4 Additive Manufacturing Cores (AM Core)
- Exposure Module (1-4 lasers)
- Heat Treatment Module
- Storage Module (for 8 new build plates or 2-8 finished build plates)
- Dual Human Machine Interface (HMI)
- Robot
- Exchange Module

MetalFAB1
Industrial Additive Manufacturing System

Modules explained

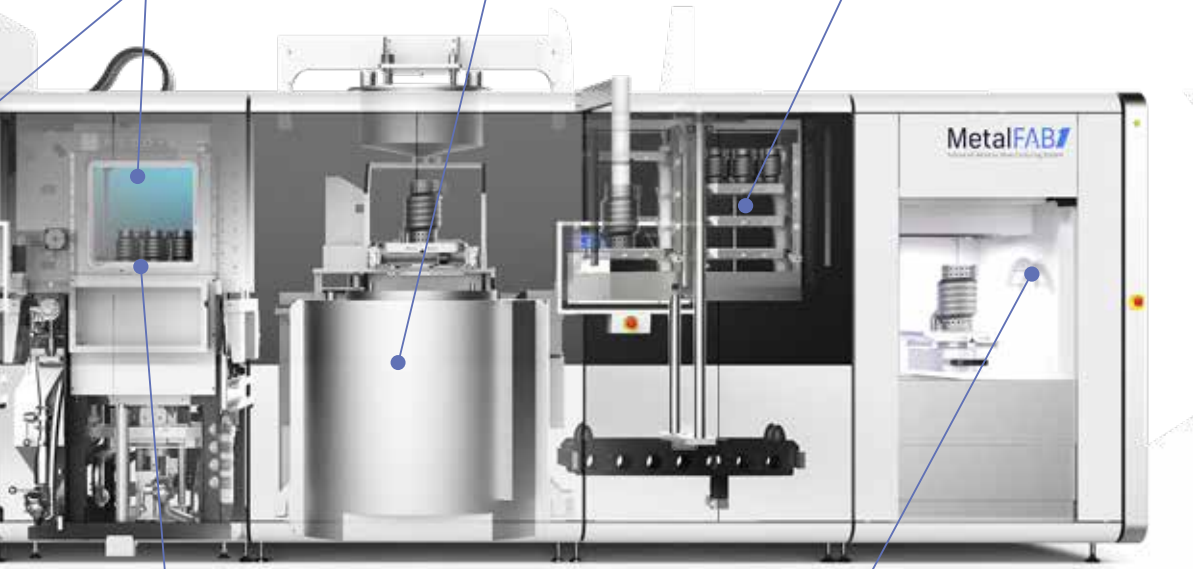
The MetalFAB1 metal additive manufacturing system is a modular design that allows our customers to configure their system to fit their applications, tune the system to the required productivity and to match the scope of process steps required for integration. Moreover, it allows Additive Industries to continuously improve the MetalFAB1 Family by adding functionality and upgrading modules. This substantially extends the service life of the MetalFAB1 system and virtually eliminates the risk of obsolescence. The following section contains a detailed explanation of each module.



Double build chamber
for maximum productivity

Furnace for integrated
stress relief

Storage module for autonomous
multi-job operation



AM Core2

Heat Treatment

Storage Module

Exchange Module

Effective Build Volume:
420x420x400 [mm]

Safe operator interface
preventing powder contact

Controls Module

The Controls Module provides the process necessities (excluding metal powders) for the MetalFAB1 system and houses a number of main components for safe operation:

- Electrical cabinet and mains connection
- System Control hardware
- Process gas supply and conditioning
- Transport gas supply and conditioning
- Cooling water chiller (water to water heat exchanger)
- Long life filter based on chalk coating technology to neutralise reactive powder particles
- Laser bays (1-4)

Main Characteristics

- Low consumption of inert gas (Argon or Nitrogen)
- < 100 ppm O2 management for safety and process quality

Additive Manufacturing Core Module (AM Core)

The AM Core Module is the heart of the MetalFAB1 system and together with the Exposure Module (see next page) the AM Core produces parts using laser powder bed fusion Additive Manufacturing with a maximum of four 500 [W] lasers (1 [kW] under development). It is the core production module of the MetalFAB1 system and consists of the following sub-modules:

- Build chamber with heated platform
- Recoater arm, bidirectional for adding powder each direction
- Powder handling system for loading powder, powder extraction (cleaning the powder from the products) and full powder recycling

Main Characteristics

- Net build envelope: 420 x 420 x 400 [mm] (x-y-z)
- Build plate heating for elevated production temperature up to 175 [°C] for powder pre-heating
- Automated build plate levelling
- Fully automated powder extraction and recycling system
- Continuously monitored inert atmosphere for powder material during operation and storage

Exposure Module

The Exposure Module works with the AM Core to provide the thermal energy necessary to melt the metal powder and is the optical heart of the system and consists of the following sub-modules:

- Laser(s)
- Beam deflection and focus system(s)
- Full build platform area coverage for all lasers
- Optical metrology and calibration system

Main Characteristics

- 500 [W] (1 [kW] under development), 1070 [nm] Yb fibre laser in 1, 2, 3 and 4 laser versions
- 420 [mm] square full field vector scanning capability
- Adjustable focus
- Automated self-calibration

Heat Treatment Module

The Heat Treatment Module provides thermal post-processing in a controlled temperature profile/cycle to relieve stress from parts attached to the build plates in order to prevent geometric distortion. Oxidation and nitride formation are prevented during the heat treatment cycle through the use of an inert gas atmosphere.

No operator interaction is necessary to initiate heat treatment as transport of build plates with parts is controlled by the handling robot with automatic door actuation and locking. The heat treatment sequence is part of the job recipe and therefore executed consistently, adding to the reproducibility of the total process. Integration of heat treatment also simplifies part and process qualification for regulated industries like aerospace components and medical products.

Main Characteristics

- 420 x 420 x 500 [mm] maximum part dimensions (including build plate)
- Up to 1100 [°C] temperature range with programmable cycle times
- Fully sealed inert atmosphere (< 100 ppm O2 management for safety and process quality)

Storage Module

Build plates with and without parts printed on them are housed in the Storage Module waiting for further processing or unloading from the system. This module enables the system to operate more autonomously with little or no operator interventions. Multiple build jobs can be executed autonomously for extended periods up to a minimum of 112 [hrs].

Main Characteristics

- Storage capacity of 8 empty build plates and as many products and build plates as possible within volume
- Design suitable for different product heights (up to 400 [mm])
- Storage module easily supports one shift operation

Exchange Module & Handling Robot

The Exchange Module provides the interface between the system and the operator. The module provides a loading/unloading platform to load empty build plates or unload finished build jobs.

The Exchange Module can be easily and safely accessed with the Additive Industries Build Plate Handling Tool, a forklift or handling crane from the outside. A vacuum cleaner is integrated in the exchange module for easy and safe removal of any residual powder in support structures or trapped powder in channels.

The Exchange Module also stores the two calibration plates for automatic calibration between two jobs. Combined with the Handling Robot, the Exchange Module arranges full automated transport of the empty build plates or finished products between the individual modules such as AM Core(s), Heat Treatment, and Storage.

Human Machine Interface (HMI)

The HMI is the main point of interaction between the operator and the system. All relevant information is displayed, and via a large touchscreen monitor, the operator can interact with the actual build process or manage planned and finished build jobs. User centred and intuitive software design supports easy operation and provides unambiguous user interaction.

Powder Load Tool

The Powder Load Tool can automatically fill the MetalFAB1 with metal powders in a safe, clean and time-saving way. The robust and certified container is prepared to come pre-filled from the metal powder supplier and can be easily connected to the MetalFAB1 by the operator. The powder loading happens under inert conditions, ensuring the quality of the metal powder.

Attaching the Powder Load Tool increases the MetalFAB1 autonomous printing. This allows for the production of multiple large jobs, without the need for an operator to refill the powder.

- Automatic powder loading, no manual powder handling
- Ability to come pre-filled from the metal powder supplier, guaranteeing powder quality
- Increased unattended printing time
- Volume of 175 (L), sufficient for multiple large size builds

Additive World Platform

Our MetalFAB1 system is fully integrated with the Additive World Platform, which supports the end-to-end 3D metal printing workflow. It allows our customers to store, share and analyse all relevant data in order to learn and improve quickly, and meet the high standards of regulated markets.

The Additive World Platform is being developed with the purpose to support the AM process in all its facets, from design to manufacturing, f, supported by a central knowledge management and (big) data solution. The Additive World Platform comprises of different components and applications that include: support for remote management of the Additive Manufacturing workflow, specific support for job preparation, machine and equipment monitoring, maintenance login and (big) data gathering and analytics. All with the purpose to support a controlled and stable manufacturing process, with continuous improvement of uptime and process quality to lower the cost per part.


MetalFAB1

Additive World
Platform

The platform offers a number of functions to support the core additive manufacturing process, including the following:

Design

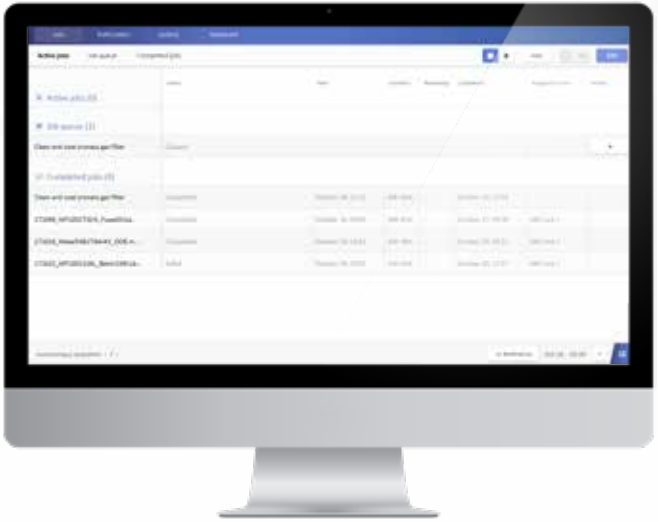
Apart from the workflow to support the management of part optimisation, the Additive World Platform offers the functionality to store all relevant part data in a single place, including CAD and CAM data – all governed under version control that manages version history and is used to link part versions to production builds, allowing a full part history overview in the system.

Work Preparation

The planning and preparation module includes functionality to support the sales process, cost price calculation, additional functionality on existing job preparation packages as well as insight into machine planning, scheduling and production queues.

Print Process Management and Quality Control

The print process management functionality supports the workflow of combining scheduled parts into builds and defining the build recipe based on part properties, while storing all relevant data in a single repository throughout the build process. This allows full visibility of job history, storage of relevant quality control data and job reporting. Furthermore, it supports the scheduling of builds distributed across different locations, machines, build plates and materials.



Process & Application Development

Additive Industries' skilled and experienced Design for AM professionals will give the customers high quality support in design, application and business case development. They are also happy to provide training in Design for AM as well as assessment of customer parts for suitability of manufacture in AM.

Application Development

Our Application Development team will help you to transform your idea to series production. Integrated industrial Additive Manufacturing enables product customization and eliminates the need for complex logistic chains. By assessing all aspects of your value chain, product application and manufacturing volume we will jointly specify product requirements for the MetalFAB1 system configuration and help reshape your supply chain.

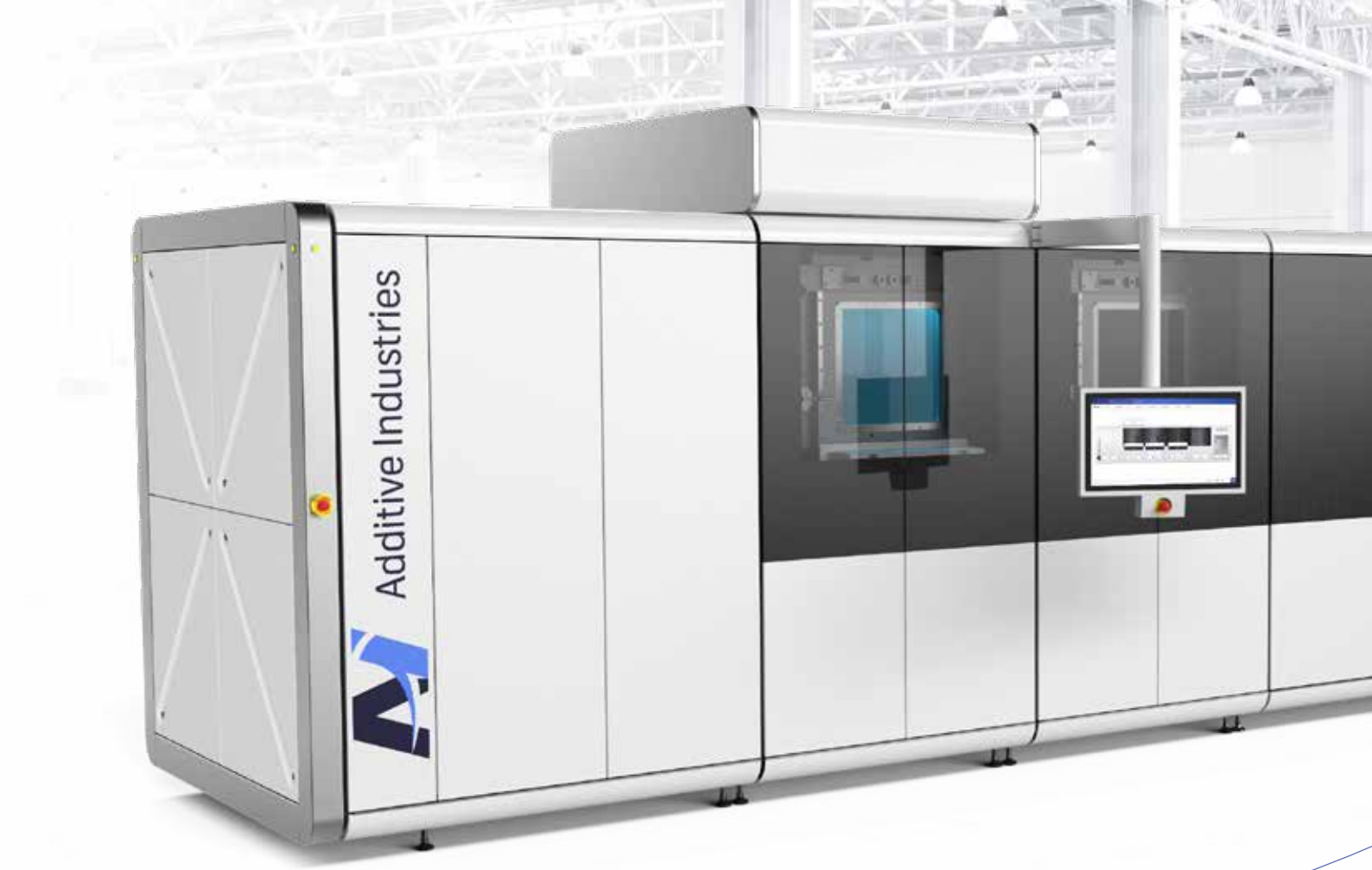
Material & Process Development

To ensure a seamless introduction of new materials and processes, Additive Industries supports you in selecting materials, developing and validating optimal build process settings and post-processing options. Process predictability and part quality will be assured and unexpected build process behaviour will be prevented.

Qualified powder characteristics are fundamental for predictable and repeatable product quality. Additive Industries offers a range of material qualification and validation services, assuring the constant supply of qualified powder.

Customized Module Development

With customized modules the functionality of MetalFAB1 can be tailored to your process flow in order to increase flexibility and productivity. For example, future modules can offer part separation or surface treatment processes to create a fully integrated industrial grade production system. Closely cooperating with our customers we will define, develop and manufacture customized modules to increase the MetalFAB1 system flexibility and extend your system's lifetime.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3-Stage support

1 Self-support

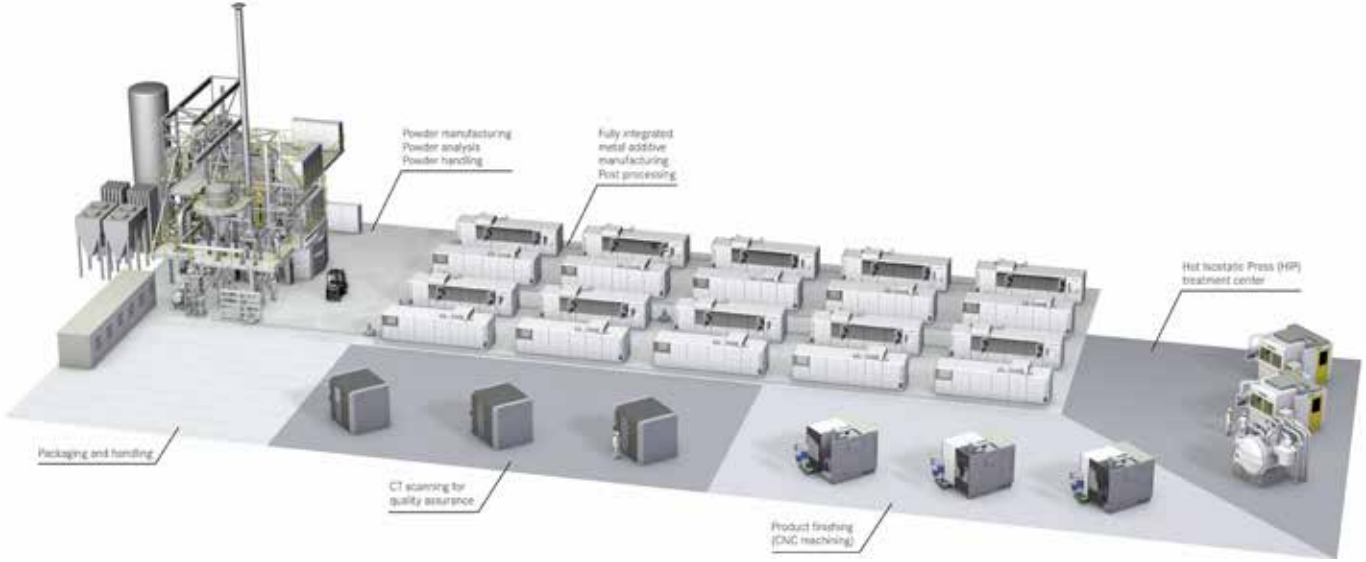
2 Remote support

3 On-site support

Comprehensive toolkit

Customer Lifecycle Support

After a successful MetalFAB1 system installation at the customer's site, Additive Industries provides onsite classroom and hands-on training to transform our customers into skilled professionals in operating and maintaining our systems. Additive Industries' highly skilled and experienced Customer Lifecycle Support team will help train our customers to maximize the system manufacturing uptime. This is done through immediate hotline response times, online live video monitoring (MyRemoteCoach), remote training, periodic maintenance and via fast delivery of spare parts and consumables. We employ state-of-the-art technology and tools to continuously monitor system health in order to optimize system availability and productivity, to minimize (remote) diagnostic time and to allow for remote equipment and software maintenance. When the situation demands, Additive Industries stands ready to offer customers our on-site support and maintenance services to ensure that the highest possible uptimes are achieved.



In collaboration with:

SMS group

Scale4Series

The breakthrough in additive manufacturing series production
A fully integrated end to end industrial additive manufacturing chain

Additive Industries has partnered with SMS-group to offer turn-key integrated metal AM factories. The Scale4Series AM-factory integrates all process steps from powder atomization to part finishing and quality inspection. The proximity of the powder atomizer allows fully customizable powder life cycle protocols at lowest cost and controlled material re-use. Together with a scalable post-processing and quality inspection eco-system, full functional parts will be produced while maximizing equipment utilization at lowest total costs.

Powder atomization plant

- Induction melting of metals in crucible under vacuum
- Atomizing of liquid metal by means of pure argon
- Integrated powder analysis and classification
- Industrial-scale pilot plant for fast progress in powder production

SMS group

SMS group is a globally leading partner for the metals industry. As a family-owned business headquartered in Germany, quality and innovation is in their DNA. SMS group has extensive know-how in design and process engineering of vacuum melting plants and has transfered this expertise to powder production.

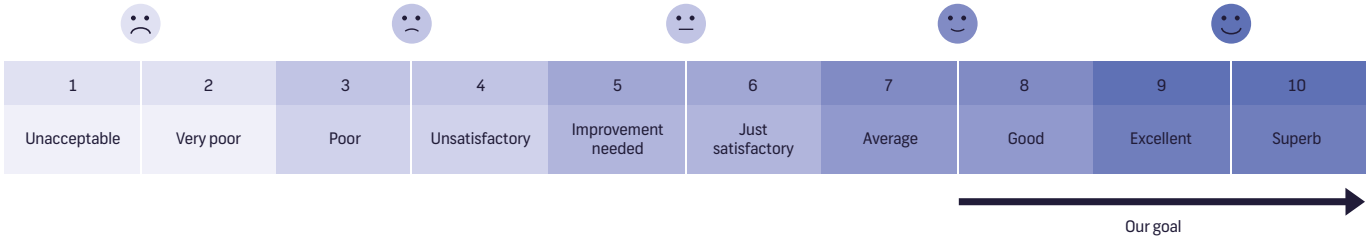
Your benefits

- Reproducible, high quality for series production due to control of integrated process chain from powder production to finished product
- Process optimized for maximum productivity and lowest total cost
- Modular and scalable concept
- Turnkey supply of complete additive manufacturing plant
- One point of contact
- Worldwide network for support

Customer Satisfaction

The #1 priority of Additive Industries is customer satisfaction! Only if you are a happy customer, can we truly execute on our ambition to accelerate to the Top 3 of our market. Therefore, we have implemented a structured method to stay in touch with our customers and get continuous input for improvements of both our product portfolio and our organisation. We measure customer satisfaction through:

- Initial installation interview at handover after the Site Acceptance Test by dedicated Customer Lifecycle Support engineer & Key Account Manager
- Direct contact with your dedicated Customer Lifecycle Support engineer & hot-line (back-up)
- Weekly call from dedicated Customer Lifecycle Support engineer to your operating team discussing system availability and utilization report (results are discussed weekly in Additive Industries Management Team)
- Quarterly business review meeting with your Key Account Manager
- Annual independent customer panel



Notes

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