FONON CORPORATION

3D FUSION™

NANO POWDER DIRECT METAL SINTERING SYSTEMS SPECIFICATION

About

Fonon Additive Manufacturing Technologies encompass 3D FUSION TECHNOLOGY or 3D Laser Metal Sintering (Commonly known as Printing) Technologies.

Fonon's 3D FUSION™ or 3D Laser Metal Sintering (Printing) process is an emerging additive NANO Powder Manufacturing Technology with a presence in the medical industry as well as Manufacturing (Mold fabrication and Repair), Defense, aerospace and high technology engineering and electronics sectors. 3D Laser Metal Printing is a layered, digitally driven additive manufacturing process that uses high quality focused laser energy to fuse metal NANO powders into 3D objects.

For the best performance Fonon's systems are optimized for nano powder with a certain specifications. To insure consistency Fonon sells a range of nano powders to ensure the best performance of our precision 3D laser sintering process.

Equipment Design Consideration

We solely develop all 3D Direct Metal printing systems for specific customer requirements, targeting maximum performance for 3D printing of specialized designs, parts and applications. Our designs allow customers to optimize expensive nano powder consumption, reduce inert gas flow rate, optimize throughput verses surface roughness, minimize powder fill up volume in the process chamber, define optimal laser power requirements, optimize system costs in relation to application (design for the warhead 3D metal sintering system is different from the design of medical contact pads mold forms prototyping, even if they have the similar horizontal cut dimensions).

We bring forth over 100 years of laser equipment design experience into the world of 3D Metal Fusion Technology and Equipment

Combined with our extensive experience of integrating Vision systems into laser equipment, and our 3D engraving capabilities experience with submicron accuracies of non-dimensional Zero Width Laser Cutting Technology™ equipment together with real size shipbuilding laser cutting machines, positions us as one of the preferred premium suppliers of the revolutionary 3D Metal Fusion Equipment utilizing the Direct Metal Sintering process in "high volume additive manufacturing" or prototyping of the most challenging and sophisticated parts and components in the Industry

Typical applications for 3D Laser Metal Printing technology:

- Fabrication of metal molds with sophisticated internal structure
- functional and marketing testing of quality production prototypes
- manufacturing of highly complex geometries
- manufacturing of customized or individually fitted complex metal parts from specialized NANO powder (replacement joints, aero foils, emergency replacement parts)
- Entrance into a new generation of 3D warfare and detonation devices manufacturing for both military and civil purposes. Allows replacing 100's of warhead components with just few from 3D printing, achieving intricate designs to control explosion patterns, blast directions, and other specifications of the warheads for specific applications.

Medical applications

Early adopters of 3D Laser Metal Printing for medical orthopedics benefit significantly from the ability of 3D Laser Metal Printing to manufacture complex geometries and structures in high grade NANO powder such as titanium. From patient-specific implants to ultimately, volume production of orthopedic implants featuring hybrid structures and textures; 3D Laser Metal Printing has the potential to unlock manufacturing capabilities that combine free-form shapes and intricate lattice structures that improve Osseo integration, leading to much improved patient outcomes.

Industrial applications

From tooling inserts featuring conformal cooling channels, through to lightweight structures for challenging and critical high technology applications, 3D Laser Metal Printing significantly reduces the constraints on designers. This design freedom results in optimized structures and shapes that would otherwise be constrained by conventional processes or the tooling requirements of large volume production. 3D Laser Metal Printing helps to reduce lead times, reduce tooling costs and permits the creation of designs not previously possible.

Aerospace applications

From aero foils and to lightweight devices with comprehensive and intricate internal structures, 3D Laser Metal Printing significantly reduces the constraints

on designers in aerospace industry. 3D Laser Metal Printing helps to open the horizons in design, lead times, and tooling costs allowing the creation of structures not previously imaginable.

Military applications

From warheads and special purposes bullets to spare parts of the military equipment. Opens a way into a new generation of 3D warfare and detonation devices manufacturing for both military and civil purposes. Allows replacing 100's of warhead components with just few from 3D printing, achieving intricate designs to control explosion patterns, blast directions, and other specifications of the warheads for specific applications.

In some cases it will be possible to print the head sometimes with internal content.

Fonon's 3D Fusion™ - Direct Laser Metal Sintering

- Fonon's 3D Laser Metal Sintering is digital additive manufacturing technology that uses a high powered laser to fuse fine metallic powders layer by layer together to form functional 3-dimensional parts.
- The process is digitally driven and formed from 3D CAD design files layered every 10 to 100 microns.
- The process then "prints" the part by direct laser sintering and fusing inn of an precise technological layer of metal powder, deposited evenly above the "printing" part by a flat powder dispenser. Practical nano powder layers are ranging from 20 microns to 200 microns, and depend on parts growth range (3D printing speed) in compromise to desired quality and surface roughness, and material density.
- Fusion between the layers is happening in a tightly controlled inert atmosphere, particularly for titanium and some other oxygen sensitive metals. Once complete, the part is removed from the process chamber and undergoes post processing, including heat treatment, surface finishing and coating as per part design specification.

CAD-driven direct manufacturing in a wide range of metals

- Functional testing of production prototypes
- Economical manufacturing of organic or highly complex geometries
- Rapid low-volume manufacturing of metal parts

About 3DF150 - (3D Fusion™ 150)

The FUSION 3DF150 features a hermetic laser sintering chamber purged by high purity nitrogen, argon or other process gas for optimized sintering atmosphere, critical for high quality end result, in terms of metal density, internal metal quality with no oxidation and pores. It is particular crucial when building 3D parts from highly reactive NANO powders such as titanium, where minimized oxygen content is critical.

For non-reactive NANO powders one can use a different process gases, like nitrogen, argon, or even, in some cases CO2 gas.

The 3DF150 has external feeding and sealed recyclable powder containers with locks to allow their removal or connection while the process is running, keeping the entire process under the inert atmosphere. One can replace the feed container without process interruption for adding NANO powder, or returning the overflow powder into the main system.

The 3DF150 has incorporated years of laser system, material processing and powder handling design experience, based on real life manufacturing industry requirements.

From series production of implantable devices to complex lattice structures or detailed aerospace geometries, the 3DF150 is capable of fulfilling the requirements of a manufacturing system. With the extended Z-axis option it is possible to build parts up to a maximum height of 350 mm.

All file and data preparation is done off-line in an office environment and whilst the system can be a tightly controlled manufacturing cell, the file preparation software also features useful process development tools for high level users.

Nano Powder Materials

Fusion 3DF-150 system is able to use a wide range of materials; Stainless Steel, Inconel, Tool Steel, Cobalt-Chromium, Aluminum and Titanium

3DF benefits and features

- reduce product development times
- reduce mold and tooling costs with dramatic reduction of lead time
- puts product on the market in weeks rather than in months

- produce products with complex geometries and internal structures
- optical or mechanical Z axis capability
- double productivity if 3DF150 equipped with one or two Sintering Heads coupled with one or two laser sources. Heads can be configured for independent operation or Master/Slave configuration when one head is precisely following the operation of another.
- ideal for aerospace and medical device applications

3DF Specification

Max. part building area	240mm – 400mm in diameter to accommodate all inscribed shapes and forms into circular (F=240 mm – 400mm) build chamber diameter, with 250 mm – 420mm Z' height Build chamber Z' axis extendable from 150 mm to 400mm
Extended Part Building area	2 Sintering Head Master/ Slave configuration, or 2 heads works independently from each other

SINTERING SPECIFICATIONS

Build rate*	5 cm^3 - 40 cm^3 per hour
Printing speed CPS	400 - 1000
Printing speed	2000 - 3000 mm/s
Positioning speed (max.)	6000-12000 mm/s
Layer thickness	20 - 100 µm
Min Wall Thickness	150 – 1000 mkm
NANO powder**	Aluminum AlSi10Mg, Stainless steel 316L and 17-4PH, Titanium Ti6Al4V, cobalt-chrome (ASTM75), Inconel 718 and 625

LASER SPECIFICATIONS

Laser beam diameter	70 µm diameter at powder surface for 200 Watt laser 135 µm diameter for 400 Watt Laser, 400 µm for 1000 Watt laser.
Laser options	200 W, 400 W, 1000W
Alignment	Red aiming beam.
Additional Laser	2 Lasers available for Dual head operation

MECHANICAL SPECIFICATIONS

External dimensions***	1700 mm x 800 mm x 2025 mm (Length, Width, Height)
Weight	1,000 kg – 2,500 kg depends on configuration
Power Requirements	230 V 1 PH, 16 A
Shop Air Requirements	ISO 8573-1, 18 l/min. @ 1,5 bar

INERT GAS CONSUMPTION

3DF Specification

In Operation	Ar/N_2, 2,5 l/min
Venting	Ar/N_2, 100 l/min.

* Build rate is dependent upon material, density & geometry. Not all NANO powder process at the highest build rate.
**Additional nano powders. We are expanding the range of nano powders working well with our Laser Metal Sintering systems. We have a range of NANO powder in development; please contact us with your requirements.
*** Dimensions are without accessories.

Laser Sintering heads options

Single or Dual Head Configuration
Optional Dual Head master-slave configuration
2 units of Fiber Lasers configured for Dual head operation
3D package for focal distance alignment without mechanical Z-axis.
Master/ Slave configuration or both heads works independently from each other.

Software

3D PRINTING software FUSION 3D™ with Multilanguage support

Fonon 3DF systems require the use of commercially available file preparation software. The necessary software should have the functionality to create 2D slices from a 3D CAD model and export those slices to individual files in the PLT, DXF, or BMP format. Our 3D Machining utility will import those files and create a 3D printing job that can be loaded into our FiberScanC3 software. It will let you save your work as a project. The software's ease of use and detailed instruction manual make the process of creating a 3D printing job easy.

Further information and advice on how to choose what is best for your needs is available on request.

Applications training

To gain maximum benefit from your investment in additive manufacturing, hermetic laser sintering casting and injection molding technologies from Fonon, comprehensive training programs are available, tailored to the exact needs and experience levels of users. In addition, Fonon periodically organizes user group forums where users can share experiences, gather new information on developments and contribute to shaping our technologies for the future.

For more information please contact the additive manufacturing team to discuss training options and upcoming events for users.

Safety Considerations During Operation 1064 nm wavelength laser light emitted from this laser system is invisible and may be harmful to the human eye. Proper laser safety eyewear must be worn during operation.
21 CFR 1040.10 Compliance This product is a Class 1 laser as designated by the CDRH and MEETS the full requirements for a stand-alone laser system as defined by 21 CFR 1040.10 under the Radiation Control for Health and Safety Act of 1968. As an added level of security, a redundantly switched safety interlock system helps prevent accidental exposure to excess laser radiation. Plus, the system is equipped with an electrical power manual reset, a key-locked

laser power switch and a remote interlock connector. Finally, the system has audible and visible emission indicators with five (5) second emission delay settings. All these features, in combination, constitute the laser radiation safety system, which allows the equipment to be used in a safe and secure manner. CLASS I LASER PRODUCT

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