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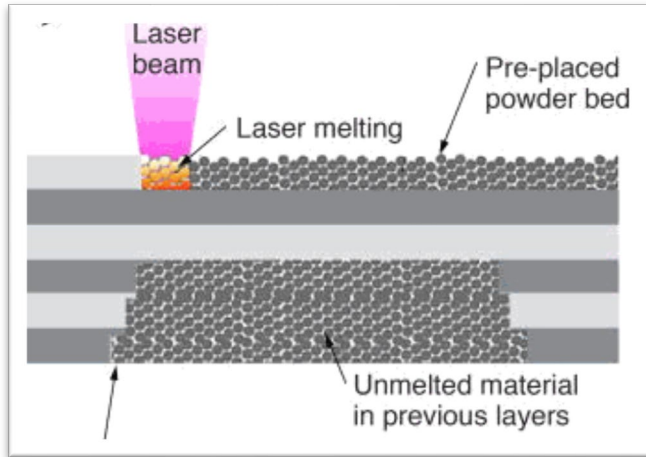
3DF-120D FUSION

Dental Laser Metal Printing System



3D Printing Introduction

The LPC 3D FUSION™ or 3D Laser Metal Sintering (3D Printing) process is an emerging additive NANO Powder Manufacturing Technology with a presence in numerous industries including dental, medical, aerospace and defense. 3D Printing has diverse applications including the manufacturing of highly complex or unique geometrics, fast track prototyping, and mold fabrication & repairs, to name a few using



new emerging technically driven applications in high-tech engineering and electronics. 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.

LPC is a USA manufacturer with over a combined 100 years of in-house laser equipment design expertise. This core competence along with decades of designing and manufacturing laser-based systems has enabled our first generation of 3D Printers to emerge as the industry standard.

System Description

The 3DF-120D Fusion Laser Metal Printing System is designed specifically for the dental industry to accommodate the price/performance requirements of dental labs.

One of the most common applications of this system within dentistry is the quick production of custom sized crowns, braces, implants, or surgical guides. Additive manufacturing allows a dentist himself to produce crowns very quickly following the scan of patient's teeth.

The development of this affordable, new generation 3D Laser Dental Metal Printer provides a small footprint in a cost-effective way to produce high-quality individual and customized designs.

An optimally sized build chamber of 120x120x100mm allows the user to select between multiple spot sizes and spreader blades resulted in a small footprint and reduced need for auxiliary equipment.

The system is built in Laser Photonics' conventional tower design where all controls are located at the top of the system eliminating contamination of electronic components with metallic and conductive powder. The vertical build of the system allows for placement on an engineering desktop or in small dental offices. With low power consumption, the usage of conventional UPS provides continuous and non-interrupted operations for lengthy multi-day process' during 3D printing.

Other features include cassette-to-cassette powder feeding and collection system which can be equipped with an inert gas handling module, depending on application needs.



Equipment Design Consideration

From standard models to customized 3D Printing Systems, we consult directly with our customers to optimize each 3D Printer to meet their unique requirements targeting maximum performance for specialized designs, parts and other unique applications. Our discussions allow customers to minimize nano powder consumption, reduce inert gas consumption, optimize throughput verses surface roughness, minimize powder residue in the process chamber, define optimal laser power requirements and reduce system costs in relation to customer applications (design for a warhead is different from the design of medical contact pads mold forms prototyping, even if they have similar horizontal cut dimensions).

Medical Dental Applications

Early 3D adopters of Laser Metal Printing for medical orthopedics benefit significantly from the ability of 3D Laser Metal Printing to manufacture complex geometries and structures with high grade NANO powders 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 improved patient outcomes and reduced operating time-tables.



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

- LPC's 3D Laser Metal Sintering is a digital additive manufacturing technology that uses a high powered laser to fuse fine metallic powders layer by layer to form 3-dimensional parts.
- The process is digitally driven from 3D CAD design files layered every 10 to 100 microns.
- The process then “prints” the part by direct laser sintering and fusing a precise technological layer of metal powder, deposited evenly above the “printing” part by a flat powder dispenser. Practical nano powder layers range from 20 microns to 200 microns, and depend on parts growth range (3D printing speed) in compromise to desired quality, surface roughness, and material density.
- Fusion between the layers is ongoing in a tightly controlled inert atmosphere, particularly for titanium and 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.

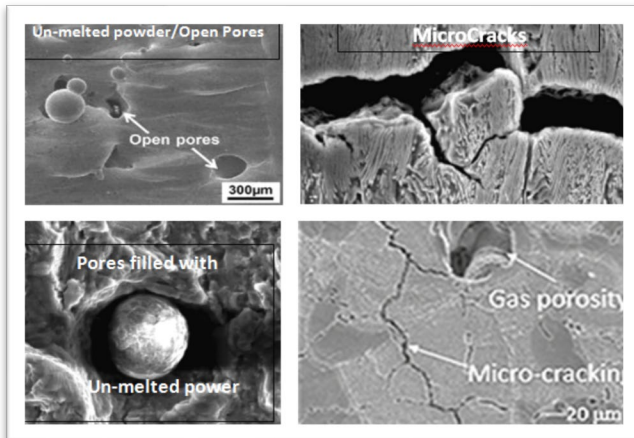
About LPC Fusion 3D Printers

Each 3D Printer features a hermetic laser sintering chamber purged by high purity nitrogen, argon or other process gas creating an optimized sintering atmosphere, attention to detail is critical for high quality end results, in terms of metal density and internal metal quality with no oxidation and pores. It is particularly crucial when building 3D parts with highly reactive NANO powders such as titanium, where minimized oxygen content is critical. For non-reactive NANO powders, one can use different process gases like nitrogen, argon or even, in some cases CO₂ gas.

Nano-Powder Distribution and Recovery System

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

Our simplified gravity based nano-powder dispense and recovery system not only reduces the size of our system on your production floor, but also eliminates closed-loop system, used by alternate suppliers, where inert gas is wasted as the transportation vehicle as well as unnecessary maintenance time cleaning the lines especially when changing metals for the next application.



Our simplified system materially reduces the introduction of moisture into the nano-powders and partial pressure in the build chamber that can lead to oxidation and other undesirable elements during the build cycle.

Our 3D systems have 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, our 3D Printers are 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 while 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

LPC 3D Printers are able to use a wide range of materials including stainless steel, cobalt-chromium, titanium and aluminum with continued focus in expanding the range of Powders.

- Stainless steel, 316L
- Titanium, Ti6Al4V

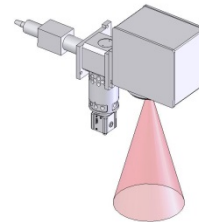
Build rate is dependent upon material, density & geometry. Not all powder process at the highest build rate.

Additional powders. We are expanding the range of powders working well with our Laser Metal Sintering systems.



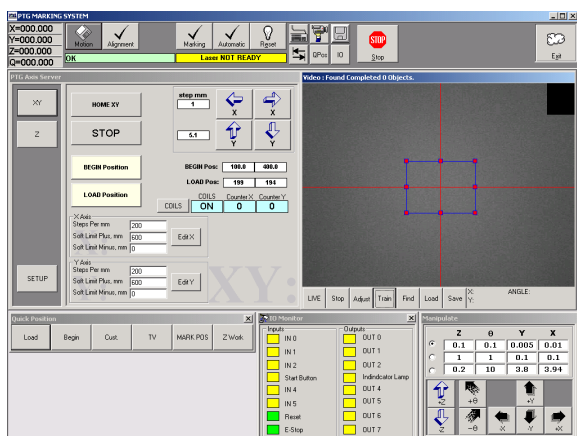
LPC's 3D Printer Benefits and Features

- 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 when our systems are upgraded to incorporate multiple Sintering Heads coupled with multiple laser sources. Heads can be configured for independent operation or Master/Slave configuration when one head is precisely following the operation of another.



Vision System

Built-in coaxial vision system - camera-based monitoring system for tool repair and inline fused materials quality verification is offered as a separate line item.



The two monitors show the GUI of the Laser 3D Printing Software and the Vision System Software.

Vision Server is an application which works with a video capture card to allow a user to create, or use, a training set from which the operator can search for a trained pattern.

All functions of LPC Vision Server can be operated remotely either by command line or a graphical user interface. The LPC Vision Server functions in conjunction with several "client" applications that allow third party software, such as Laser Photonics Fusion 3D, to remote control the Vision System,

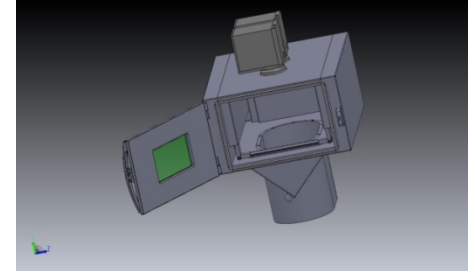
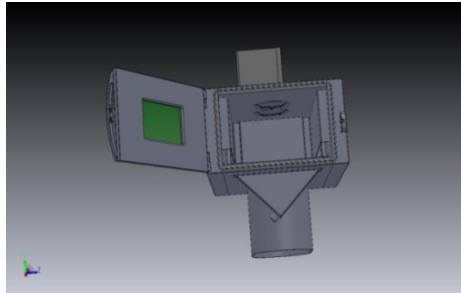
Our Vision System implements pattern matching. This involves the training and locating of a known good pattern. Then finding X, Y, and Rotation angle offsets of similar patterns. X and Y can be assigned as any user defined units. This allows precision alignment of the laser pattern for selective 3D Laser Printing for



the purpose of mold and tool repair. Vision System allows controlling porosity, allocating geometries, performing precision additive repair, detect and control build rate, conduct QC on the raw nano materials, inspect geometries, detect enclosures and particle coagulation, quality of powder deposition, and so on...

Process Chamber

Our hermetic vacuum grade process chamber includes a laser rated protected viewing window to assist in nano powder re-deposition. The chamber includes 2 precision coated windows for viewing sintering laser beams, access powder collection containers, the powder feeding and receiving container as well as the powder delivery system.



Our Vacuum grade process chamber reduces gas consumption, and keeps feeding & receiving powder containers under a common atmospheric pressure and in an inert gas atmosphere.

This design concept reduces potential water vapor and gas below artificial valves including the dew point temperature. Finally, our build chambers are designed for single and dual head configurations.

Direct Drive Digital Technology

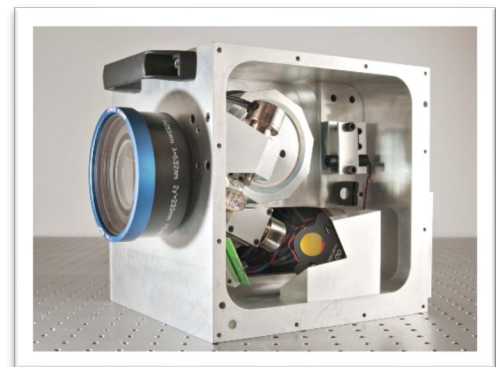
LPC's digital direct drive technology extends the company's fully digital solution platform by providing the highest dynamic performance with closed loop XY-stage precision, as well as comprehensive position feedback and process monitoring across the entire family of High and Low Power motion. This enables applications that require both high precision and high throughput, a property mix unachievable with conventional motion systems for beam-positioning or material positioning technologies. With modern control architecture and highest quality drive components from companies like Siemens and Bosh, LPC systems have unmatched reliability and smooth performance for high quality prints.

Digital encoders are integrated into all of LPC's Direct Drive motion systems with Fusion 3D Systems and Fiber Scan dynamic focusing units. The use of closed loop digital positioning enhances precision without compromising dynamic performance or mechanical dimensions.

Proven Galvo Based Technology

The Digitally controlled closed loop optical system exceeds the high dynamic performance of the industry proven galvo based solutions. It enables a laser traveling with a positioning resolution of 19-20 bits, exceptionally low noise value, best linearity and lowest drift.

A comprehensive 20-bit communication is completed via LPC's family of high power systems featuring the industry's first fully digital architecture. 3D Build Pitch can be precisely adjusted for 3D layering applications and eliminates most of the unwanted effects leading to a geometry distortion.



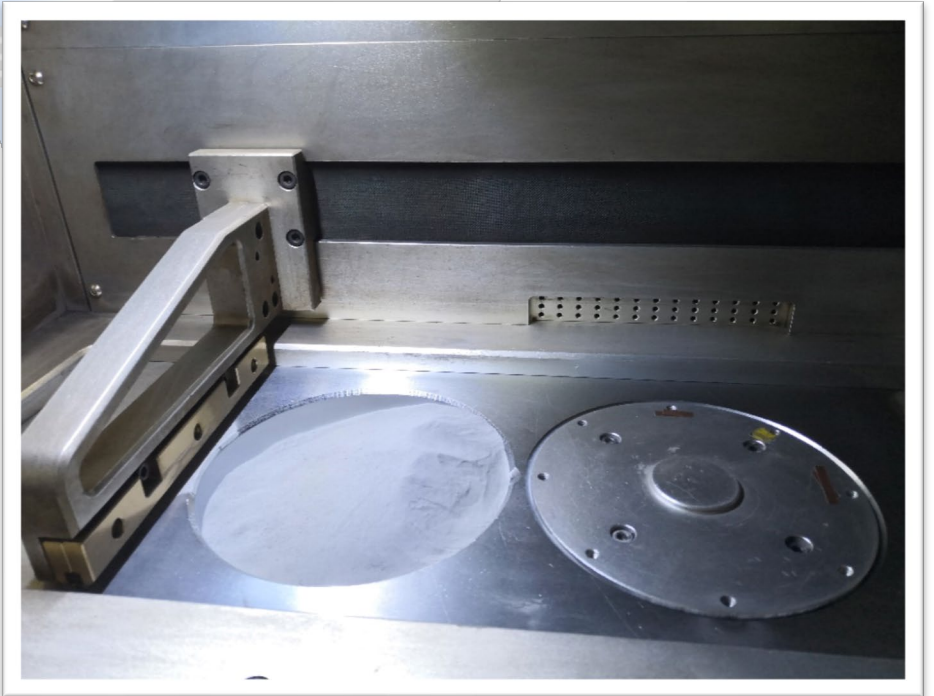
Attention to Details

Precision 3D applications require a small-spot-size laser beam to be precisely positioned within a large build area, LPC's digital closed loop direct drive technology helps optimize build rate, precision, beam positioning speed, resolution and linearity, while substantially reducing drift effects.

The digital solution extensively enhances the range of diagnosis and communication capabilities between the 3D System and remote computer providing information on operating hours, serial number, manufacture information and essential operational data. Thus, defects can be quickly detected and eliminated.

To boost speed and/or positioning accuracy, LPC can equip its digital servo firmware with multiple Control algorithms and parameter sets (tunings). Switching between different algorithms or sets (even during processing) allows Beam Positioning head dynamics to be reconfigured and thereby optimally adapted to particular task requirements.

Fusion 3D System Beam Positioning Heads allow real-time monitoring of all key operational states of the system and are equipped with a coaxial vision system. As a result, the 3D Part build process can be simulated or monitored.



3DF Specifications

	3DF-120D
Maximum Build Chamber Diameter	F = 155 mm
Max. inscribe rectangular build area	120 x 120 mm
Build chamber Z' axis	100 mm
Laser Power	100W-200W
Printing Speed	1.0 m/s
Positioning Speed	11.0 m/s
Good Printing Quality	340 cps
High Printing Quality	230 cps
Spot diameter at 1/e2 Ø spot (µm)	30 µm

Generic Sintering Specifications

Build rate*	5 cm ³ - 40 cm ³ per hour
Printing speed CPS	400 - 1000
Printing speed mm/sec	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	30 µm diameter at powder surface for 3DF-150 to 70 µm diameter for 3DF-500 (Subject to laser/focusing components combination).
Laser options	100W, 200W, 400W, 1000W, 2000W
Alignment	Red aiming beam.

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

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

Inert Gas Recirculating

Inert gas recirculation system consists of 3 major parts: gas blower, vacuum tide filter and gas cooling unit with heat exchanger. All gas handling critical parts and components are of a highest quality carefully selected from the best names in the industry.

Laser Sintering Head Options

- Single 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

For demanding application sintering heads are thermo-stabilized to assure the highest metal printing quality and reliability.

Software

3D PRINTING software FIBER SCAN FUSION 3D™ with Multilanguage support. LPC 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 customized FiberScanC3 software designed for prototypes and volume manufacturing. 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.

Advanced Fiber Laser

- The most advanced high power fiber laser used in laser sintering systems
- Lowest beam divergence of any one micron laser for all power levels (large dynamic range)
- A 5x smaller output beam spot size diameter than a CO₂ laser¹
- Lowest maintenance and operational costs among all industrial lasers
- High electro optical efficiency: wall plug efficiency >28% vs. 2-5% of YAG lasers
- Low cooling requirements
- Cost savings in ownership

Laser Power available in 200W,

Recirculation chiller

Recirculation chiller is used to cool down or keep at constant temperature optical couplers, sintering heads, gas heat exchangers.

- Recirculation chiller with internal refrigeration unit
- Di water cartridge
- Cooling capacity: 5000watts at 20degrees delivery water
- Cooling temp. Range: +5 deg. C to +35deg C



Applications Training

To gain maximum benefit from your investment in additive manufacturing, hermetic laser sintering casting and injection molding technologies from LPC, comprehensive training programs are available, tailored to the exact needs and experience levels of users. Each machine comes with a one year warranty.

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 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

AVOID EXPOSURE
INVISIBLE LASER RADIATION
IS EMITTED FROM THIS APERTURE

COMPLIES WITH 21 CFR
1040.10 AND 1040.11



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