

INSSTEK NEWSLETTER



Special Articles

-MX-Lab for material research -CVM powder feeding system -Gradient material study

MAIN SUBJECT

- **1. Company Introduction**
- 2. Product: MX-Lab
- 3. Technology: CVM feeder
- 4. FGM Material study
- 5. Event: MWJ2020

INTRODUCTION : InssTek



Figure 1. InssTek company view

InssTek Co., Ltd. is a leading company in the field of Additive Manufacturing (AM), with the goal of commercializing DMT (Direct Metal Tooling) additive technology. InssTek was the first to succeed in developing metal 3D printing technolo -gy in Korea. InssTek provides total solutions for AM based on core technologies such as DMT 3D metal printing, laser material processing, and sys-

tem development. From product design to production, all the technologies required for customers to use InssTek's metal printers have been developed in-house to provide an easier and more enjoyable environment for the users. Through continuous innovation, InssTek has become a leader in the metal 3D printing market. InssTek's main products are MX-Standard (including MX-600, MX-1000), MPC (Machine for Porous Coating), MX-Grande (customized equipment), and MX-Lab a metal printing equipment for innovative material development. MX-Lab was launched in November 2019, along with InssTek's unique CVM (Clogged Vibration Method) Powder Feeder, showcasing an advanced technology in the metal 3D printing market. In this newsletter, we introduce our newly launched product "MX-Lab", a metal 3D printer capable for material research, and also highlight research cases conducted with our new product that will open new horizons in material development.

PRODUCT: MX-Lab



Figure 2. MX-Lab

InssTek's newly developed product, MX-Lab, is the world's first DED metal 3D printer equipped with six powder feeders. MX-Lab is a product developed for innovative material research and development. All mechanical devices are integrated into one system, including a 300W fiber laser, an optical module, InssTek's in-house developed CVM Powder Feeding System, and all other elements that operate the equipment. The product size is 700mm (width) x 700mm (length) x 800mm (height) and the total weight of the equipment is approximately 200kg, including the laser.

Specialized for material research - MX-Lab

One of the main features of MX-Lab is its stage. With the basic 3-axis structure, the machine is designed to be remarkably stable and precise. With InssTek's accumulated technology, MX-Lab is designed to be durable for long time use, withstanding the DED machine's vulnerability to the metal powder environment. The maximum size of the final printed output is a cube shape of 150mm (width) x 150mm (length) x 150mm (height), which is the size commonly used for basic specimens required for material testing.

MX-Lab includes a 2nd generation module designed with laser optics, a nozzle for powder supply, and DMT Vision for vision feedback. The advantage of using the DMT Vision is that the user can view both the left and right view of the meltpool with one camera. The module has builtin optical components for focusing the laser beam and is easy to manage. The nozzle was designed originally by InssTek and effectively controls the flow of gas and powder supply. This module is also applied to InssTek's representative MX-Standard equipment.

MX-Lab software – Material Designer

There are two types of software for using MX-Lab. First, is the MX-Lab Slicer program. It provides a more user-friendly interface and improved software functions, and produces the finished metal parts with 3D data. Various types of deposition are possible with the MX-Lab Slicer program, from simple shaped specimen to other complex shapes and figures. The second program for MX-Lab, Material Designer, is introduced in the following page.



Figure 3. Worktable display of the plater tab

MX-Lab Material Designer							- 0 ×
E CREATE HOPPER							InssTek
Tool path Operation Create the tool path operation		+ CREATE	Operation Se Defines the tool path oper	etting ation profile		View Visualize the set operations	
No 🗸 Name	Size(mm)	Height(mm)	Width	12 mi	n		
1 🗸 🐁 Tool Path Operation	12 X 12	12.00	Length	12 mi	n		
	Total :	12.00 mm	Slicing				
			Layer Number	80			
			Layer Height	0.15 mi	n		
			Toolpath Profile				
			Tool Path Spacing	0.3 mi	n		
			Method	CF			Tool Path Operation
				CFC			
				CF/CFC			
			Dwell Time	1 se	c		P nssTek
			Composition		Gradient 🔻	View Table	
			Start Layer			No Color Name	Allays
			1 10 2 0	3040	5060		
			End Layer				
			1 0 2 10	3 0 4 0	50 60		
			Gradient step 1	layer			
					SAVE	NC GENERATE NO	CODE

Figure 4. Material Designer program – Gradient setting display

Material Designer is a software exclusively designed for MX-Lab. It can generate NC-CODESs for easy and fast deposition of rectangular test plates without using 3D CAD. With Material Designer, the user can produce various material designs such as Metal Matrix Composite (MMC), Functional Graded Material (FGM), and High Entropy Alloy (HEA). By controlling the type and amount of input and formulation of the powder, the users may explore new designs of material composition for material development and research.

The main function of MX-Lab Material Designer is that 6 hoppers can be individually controlled with the program. By entering the value for each hopper, it is possible to accurately control the time of supply, amount of powder, and powder supply ratio for each individual hopper. For example, for stacking a gradient sample, the user may select the 'Gradient' menu on the program and enter the values for each hopper to generate a NC-CODE, and then easily create the powder setting values in the Program's 'Operation Setting' menu. The created tool path operation is visualized on the Program (as shown in Figure 5.). It is possible to enter what alloy will be used with the 'View Table' function, and the color displayed in the View can be changed with the 'Color' button. With MX-Lab Material Designer, various material designs can be created flexibly by easily controlling the material desired by the user. The world's first CVM Powder Feeding System, the core technology of MX-Lab, is elaborated in detail on the following page.

			Material B
			Graded Zone
			Material A
Vi	ew [.]	Table	1113310
No	Color	Name	Alloys
1		Material A	
		Graded Zone	



Design new material with **MX-Lab**

Meet the new generation of Additive Manufacturing

Simple system for easy use of DED

- Specialized for multi material research purpose
- Use of multi material available
- Easy to use singular or multi hoppers
- Remarkable user interface

Multi materials can be specified according to the user's necessity



Next generation powder feeding system

Key Features

- ✓ CVM type powder feeder
- Feeds multi materials simultaneously
- Gradually adjustable powder feed rate
- ✓ Feed rate range
 0.05~5g/min (based on Ti)
- Gravity / direct feeding available
- Impressively stable powder feed rate

Technology: CVM Powder Feeder

The core technology of the MX-Lab is the CVM (Clogged Vibration Method) powder feeding system. In general, fine metal powders are the size of several dozens of micrometers or less and have properties of sticking together due to electrostatic attraction, making the powder form a larger sized aggregate. When the size of these agglomerated powders increases, the fluidity of the powder becomes extremely low, hampering continuous powder supply of the feeder when using conventional powder feeding methods. For DED equipment, the deposition process and quality depend on how stably the various metal material powders can be supplied. InssTek devoted its research to stabilize powder supply, and in November 2019, the world's first CVM



Figure 6. Active splitting system

powder feeding system was developed. A total of 6 powder feeders, each with extremely stable powder feeding rates, are installed in InssTek's CVM powder feeding system and simultaneous supply of up to 6 different powders is possible.

In addition to the advantage of being able to mix and supply up to six powders at once, the CVM powder feeder enables accurate control of the amount of each powder supplied. The core technology of the CVM powder feeder is in the device's internal powder feeding pathway. The powder flows through a precisely designed inner path in which the amount of powder supply is controlled by the vibration motion of the powder feeder block. Powder supply may be controlled from 0.05g to 5g per minute (based on Titanium) for each feeder. Tests conducted on the CVM powder feeder revealed that it was able to supply at a rate of 0.09g of powder per minute for 46 hours straight, proving the device's stability and durability.

The powder supplied from the CVM powder feeder flows to the splitting system to be evenly divided into the nozzle. Unlike existing equipment, InssTek's MX-Lab uses a motor in the splitter to uniformly distribute the powders to the nozzle. The hose for supplying the powder is attached to the top of the module (which includes the nozzle) and is rotated by a motor while builtin parts constantly distribute the powder. Evenly divided powder ensures stable deposition of materials.

Material Research Report



Figure 7. Gradient material

Research was conducted to test the deposition of gradient material with MX-Lab. The chemical properties of the printed specimen start with Stainless Steel (SUS316L) and gradually changes to Inconel 718. The results for SEM analysis of the specimens is displayed in Figure 8 and 9. The Fe and Ni contents of the printed specimen gradually changes from SUS316L to Inconel 718. The results of this research show that MX-Lab equipment can be effectively used to develop and experiment new types of materials. In addition, producing specimen with MX-Lab dramatically reduces the production time.

MX-Lab has infinite potential to be used in the study of various metal materials such as metal ceramic composite materials, warp functional materials, and high entropy alloys. In addition, InssTek is also focusing on research of MMC (Metal Matrix Composite) specimen production using MX-Lab, in addition to FGM (Functional Graded Materials). Additional research data conducted by InssTek on FGM and MMC are available through the link below:

Link: The initial study of MMCs & FGMs



The MX-Lab equipment is based on six feeders and DED technology. All systems are integrated into one product. This FGM (Functionally Graded Material) demo

In the demo, we started with SUS316L and deposited the material to gradually change into IN718. After deposition, the specimens were analyzed by SEM & EDS & HV analysis, and the results showed stable gradual change of the material.

shows how easy it is to research new material with MX-Lab equipment.



Figure 8. SUS316L and IN718 SEM Analysis (x250)



	SUS316L	IN718
Fe	67	18
Ni	11.5	53

[Powder chemical properties (%wt)]

	Start(1%)	End (100%)
Fe	66.9	17.5
Ni	11.9	52.8

[Specimen chemical properties (%wt)]



Event: Manufacturing World Japan 2020



Figure 10. InssTek in Manufacturing World Japan 2020

In February 2020, InssTek participated in the Manufacturing World Japan 2020 exhibition held for three days in Makuhari Messe, Chiba prefecture, Tokyo, Japan. More than 50,000 visitors come to the exhibition annually. Although there was a decline of visitors due to the impact of COVID-19 this year, InssTek successfully took its first step toward bringing its technology to the Japanese market. For the main exhibition items MX-600, a MX-Standard equipment, and MX-Lab, an innovative material development equipment, were introduced. In addition, InssTek showcased its original CVM Powder Feeding System, the core technology of MX-Lab. Officials from Japan's local manufact -uring, construction, medical, heavy industry, and aerospace sectors showed great interest in InssTek's real-time demonstration of printing a rocket fuel tank with the MX-600 equipment, and were impressed by the various printing samples that were exhibited.

InssTek has been exporting its equipment to Europe, Russia and other global markets and has proven its technological excellence worldwide in various industrial fields. Among InssTek's products, MX-Lab is expected to be used in a variety of material research. With the launch of MX-Lab with unlimited possibilities, InssTek is eager to explore the Asian market, taking its first step in the Japanese market.



Figure 11. Manufacturing World Japan 2020

Appendix



InssTek has been recognized for its technology in Europe and around the world. The figure above shows statistics of articles and academic data released on InssTek's technology and products during the past 4 months. InssTek's innovative technology and product excellence have been recognized by the world market. Related articles and academic materials can be downloaded through the links on the right.

Company Info.

Street Address: 154 Shinseong-ro Yuseong-gu, Daejeon 34019, Korea Tel: (+82) 42 935 9646 Fax: (+82) 42 935 9649 E-mail: <u>sales@insstek.com</u> Website: <u>www.insstek.com</u> YouTube: <u>https://www.youtube.com</u>

Download

Related press releases & materials

2019 MM-Moduleworks & InssTek 2019 Materials Science and Engineering 2019 Metal Magazine Page.43 DMT 5 Axis AM-CAM with ModuleWorks Collaboration on simultaneous multi-axis

