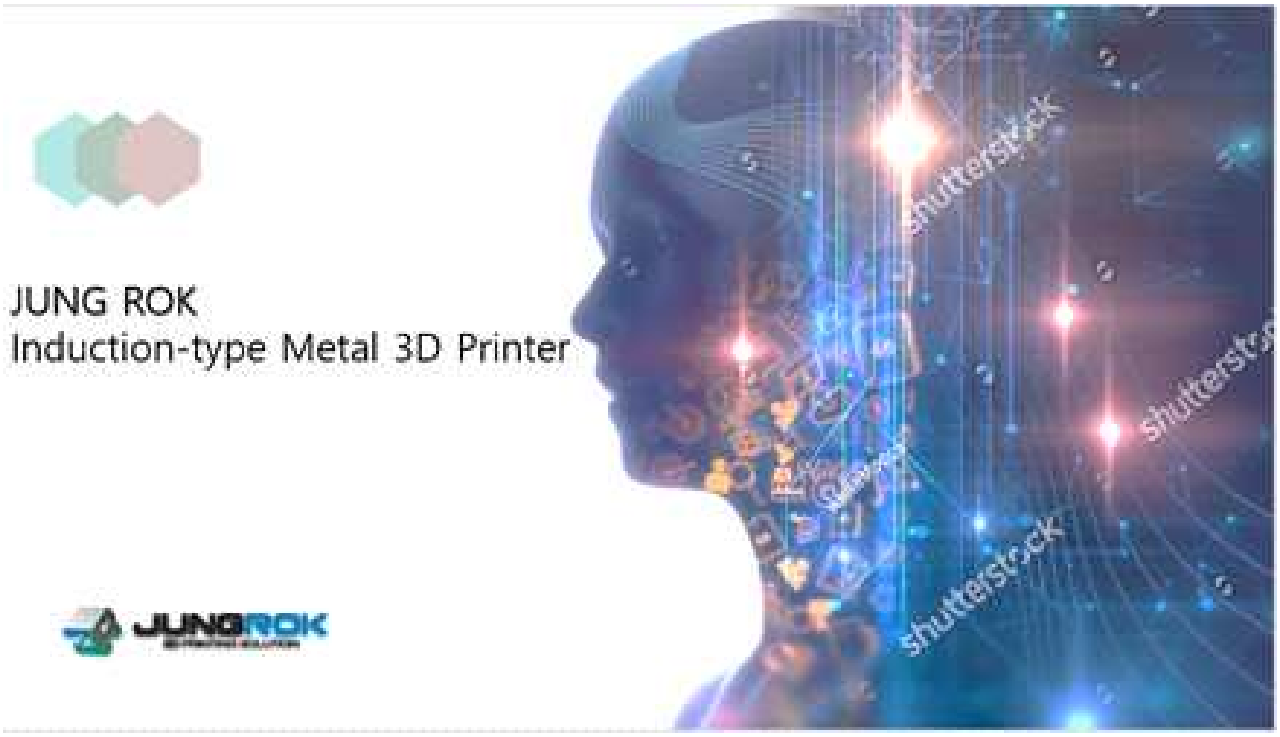


Company with 4th Industry Innovative technology

Name of Company	JUNGROK (founded in April, 2016)
CEO	Soo Yeon, Lee
Business	3D Printer, H/W and S/W
Main Business	Industrial 3D printer solution
History	2017. 4.~5. Establishment and Venture Business Certification 2017. 6. Establishment of research centre 2017.12. K-Global 300 ICT Prospective enterprise certification 2017.12. Technology transfer(Design of material spray nozzle considering flow characteristics) 2018. 9. Designation of Korea Institute of Production Technology as a partner enterprise 2018.12. Productivity management system (PMS) certification 2018.12. Technology transfer(3D pole printing technology with plasma display) 2019. 3. Designate 'Best companies to work for' (Ulsan)
Address	15, Jongga-ro, Jung-gu, Ulsan, Republic of Korea

Topic 1. DME(Direct Melting Extrusion) Method Metal 3D printer that can produce metal parts through the Additive manufacturing process by melting and extrusion by induction heating

① Technical overview

- The conventional metal 3D printing technology is formed at a high price (hundreds of bil lions ~ billions) by selective laser sintering (SLS) and this 3D printing technology has be en commercialized overseas (USA, Germany, Japan, etc)

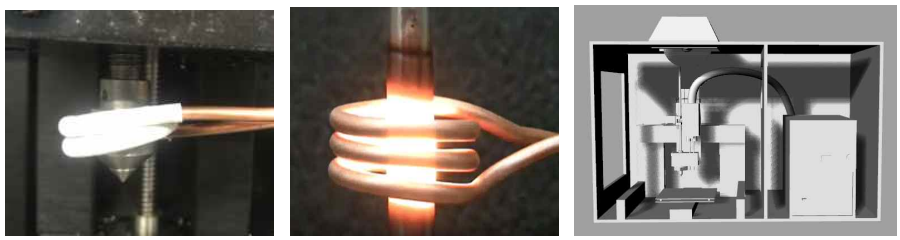
: The material used for printing is metal powder, which is several times higher than the bu lk material, and has a complicated manufacturing process and takes a long time

: In addition, the powder material is limited to the development of proprietary 3D printing technology because only the material supplied by the equipment company should be used due to the warranty problem of the equipment

: The higher the laser output depending on the melting point of the material, the higher the unit price will be

: Need to introduce new metal 3D printing technology beyond existing expensive method

- Rather than using expensive metal powders, low-cost metal wires are used to develop met al 3d printers that can produce metal parts through DME(Direct Melting Extrusion) throug h Induction Heating



<Fig .1 Conceptual drawing of additive manufacturing process for direct melting extrusion of metal wire by induction heating>

- DME metal lamination manufacturing process technology using high frequency induction heating principle has not been developed at home and abroad

② Technical Innovativeness

○ Technology standard abroad

Sector	Leading Company	Technology level of the company (To be developed)
Domestic	Jungrok	100/100
Overseas	NA	-/100

(2) Innovativeness compared to current technology

Innovativeness	Existing Technology	Technology to be Developed
Cost reduction of materials and processes	Aluminium powder 400,000KRW (265GBP)/kg Tens of millions KRW/once	Aluminium wire 100,000-120,000KRW(70-80GBP)/kg Millions KRW/once
Quick process optimization	Long time to process optimization, Less accuracy in process	Quick process optimization by different materials and applications with Deep Learning technology
Less expensive equipment cost	500million-2bnKRW (330,000-1.3millionGBP)	100millionKRW (66,000GBP)
Output Enlargement	Enlargement problem by process characteristics in the case of existing PBF(Powder Bed Fusion)	Enlargement over 300mm×300mm×300mm ⇒ Large area integrated parts manufacturing

○ IP related to the technology to be developed

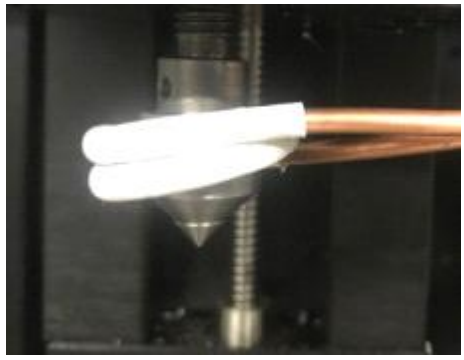
<IP status owned by Jungrok>

Type	Name	Registration/Application number
Patented	Metal 3D Printer with Induction coils	10-1635720
Patented	Direct melting-type metal 3D printer	10-1704354
Patented	3D Printer	10-1733884
Patented	3D Printer	10-1843323
Patented	Extruder for 3D Printer	10-1956918
Trademark	CHAIPEN	40-1238493
Trademark	GinKor	40-1434970
Patent pending	3D Printer	10-2018-0132527
Patent pending	3D Printer with free printing	10-2018-0132576
Design pending	3D Printer	30-2018-0050269
Patent pending	Methods for forming circuit patterns on flexible substrates	10-2018-0173919

③ Originality of the Technology

- Overseas companies mostly use metal 3D printing technology using Selective sintering me thod using expensive laser device
- There is no development case of direct melting metal 3D printer using electromagnetic in duction heating principle
- Outstanding advantages over other products in terms of materials and manufacturing costs
- Powder, which is a conventional material, is difficult to develop and expensive, and it is difficult to use and purchase it as an exclusive form of an overseas 3D printing company
- The metal 3D printer under development is available in the form of inexpensive and easy -to-use metal wire instead of powder
- Simple driving principle of new DME (Direct Melting Extrusion) method with FDM struc ture enables users to make products without difficulty

<Fiber Lasers used in SLS process>



<Direct Melting Extrusion Nozzle>

<Comparison with competitors>

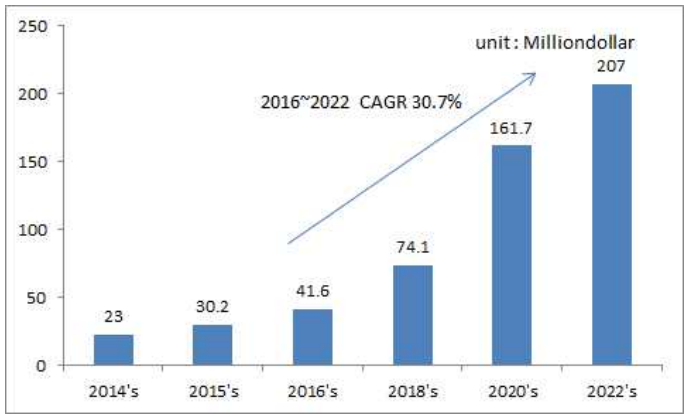
Manufacturer	JungRok	EOS	3D Systems
Country	Korea	Germany	USA
Model Name	GinKor	M290	ProX300
Build Size	300×300×300(mm)	250×250×325(mm)	250×250×330(mm)
Technology	DME (Direct Melting Extrusion)	DMLS (Direct Metal Laser Sintering)	DMP (Direct Metal Printing)
Purpose	Industrial, Resarch, Entry type	Industrial	Industrial
Using Materials	Wire type metal material	Cobalt-chrome, Aluminum, Titanium ,etc.	Cobalt-chrome, Aluminum, Nikel, Stainless Steel ,etc.
Picture			

④ Target Market Status

(Domestic market)

- Domestic market is expected to grow to 1 trillion won in 2022 (17 years by Woohlers A ssociates)
- The domestic 3D printing market is expected to reach 3,469 billion won in 2017, with an annual average growth rate of 24.1% by 2022, with growth expected at 1 trillion won
- The domestic 3D printing market continues to grow rapidly, with demand for distribution-type 3D printer FDMs centering on educational institutions
- The domestic distribution-type 3D printer market grew 71.5% from 244.1 billion won in 2016 to 418.7 billion won in 2017

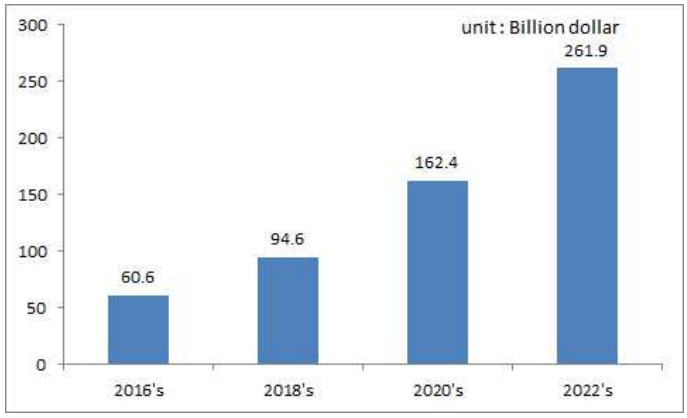
<Domestic 3D Printing Market Forecast>



(Overseas Market)

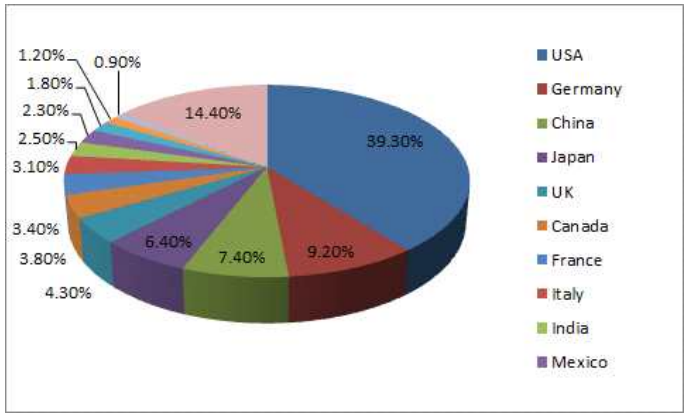
- The global 3D printing market is expected to grow at an annual average of 27.6% from $ 9.4 billion in 2017 to $ 26.2 billion in 2022
- During this period, the number of 3D printers will increase from 220,000 to 6.75 million, and FDM type printers, which are mainly applied to low-end 3D printers, are expected to increase the fastest
- Countries such as the US and China have a high share of the world's 3D printing marke t, and many companies are growing. By 2019, more than 25% of the world's manufacture rs will adopt 3D printers

<Overseas 3D Printing Market Forecast>



- The 3D printing market has the largest market share in the US (39.3%) and Germany (9.2%). These countries are active in securing original technologies and producing industrial equipment and components, while Korea has 1.8% of the market share

<3D Printing Market Share by Country>



Topic 2. PCB electrode patterning technology with atmospheric plasma

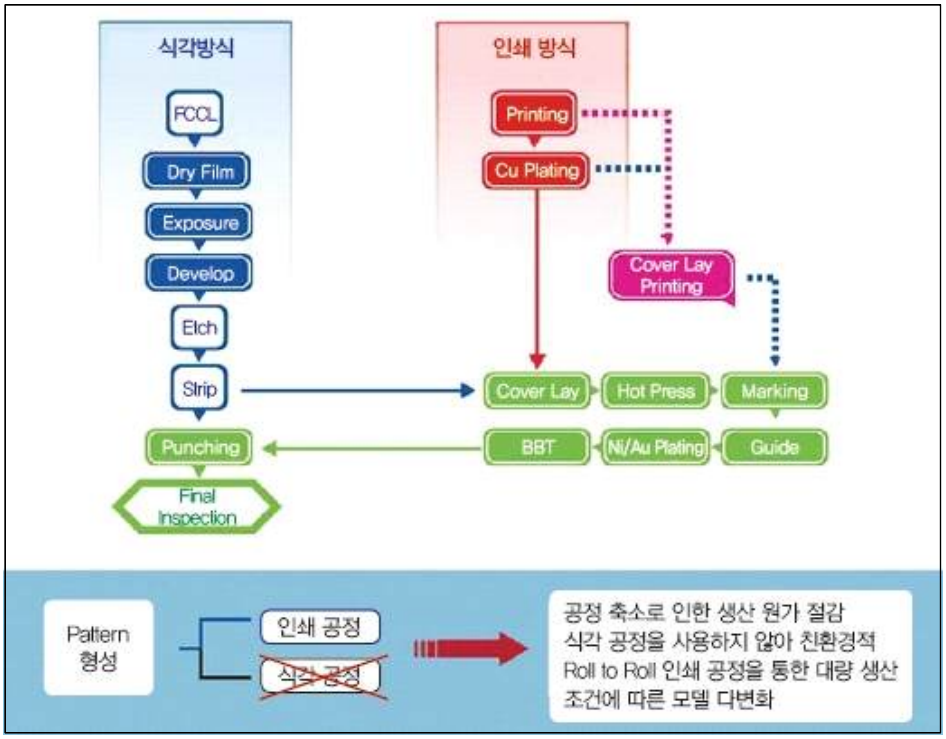
(Overview)

- Patterning technology using PCB, applied in general electrical and electronics sector of national major industry, with conductive ink and atmospheric plasma
- PCB manufacturing technology with different forms, miniaturization, no material limit in circuit boards
- ①Plasma generation module, ② PCB manufacturing technology with printing method through conductive ink output control technology
- Market creation oriented technology capable of expanding to advanced form in electronic components sector of the 4^{th} industry, and developing and expanding to such markets as wearable device, semiconductor pre and post processing equipment (under fill, side fill), micro-patterning, curved antenna, lab on a chip, etc.

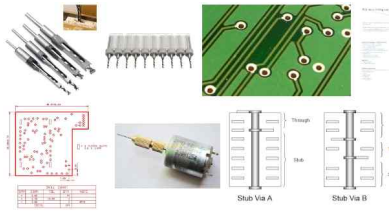
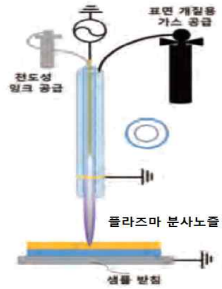
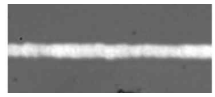
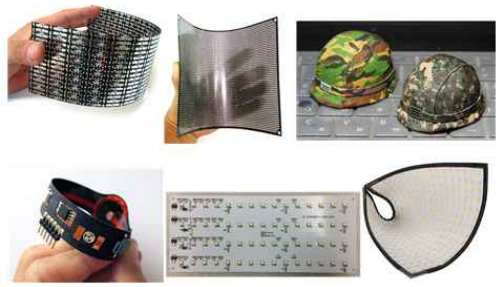
ㅇ (Technical distinction)

- Conductive ink pattern 3D Printing method with plasma jet is a technology applicable to a wide range of areas such as surface reforming and electric wiring, with it replacing etching, ashing, deposition technology, making it applicable to 3-dimensional surfaces such as plastic, glass, and metal
- Applicable to ecotechnology, medical and bio technology, energy and material industry, semiconductor and display industry, machine and parts industry, processing industry, and military weapon system through surface reforming method with plasma jet
- Productivity-increasing plasma 3D patterning technology by improving percent defective in PCB manufacturing process is advanced technology with high technical barrier, differentiated from existing technology.

<Distinctiveness in electrode production method of the technology>



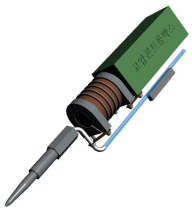
Existing technology<Etching method> → Developing technology<Printing method>

항목	Existing	Developing
Nozzle		
PCB manufacturing process reduction	Needs for changes (drill bit, jet nozzle) according to processes	Process simplification with plasma jet nozzle and conductive ink
Eco-friendly, easy handling materials	 Difficult to handle, Toxic gas	 Easy to handle, Liquid
Metal wiring	impracticable 	practicable 
PCB material	 circuit board with epoxy material FPCB	 applicable to different materials such as polymer, silicon, etc.
Form	Difficulty of miniaturizing plane structure	Capable of manufacturing in different forms
Applicable area and strengths	Existing PCB defect modification 3 dimensional shaped products Micro products (MicroLED) Bio lab on a chip market expandability Diversity in general material, form, size, and miniaturization	

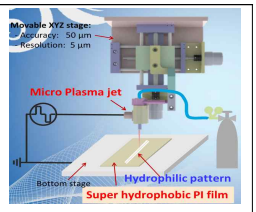
ㅇ (Applicable range and area)

- Electronic equipment development through 3D PCB manufacturing/production with plasma jet
- Capable of manufacturing 3D PCB with 3D printer, our core technology, and applicable to precision electronic components and diverse forms of product manufacturing
- Core technology fulfilling the standards of future electronic equipment, maximizing product efficiency through precision, integration of circuit board, minimizing power consumption
- Applicable to various electronic equipment of the 4th industry, with plasma jet capable of implementing different characteristics according to voltage, current, frequency, and used gas
- Capable of fulfilling requested services by clients with its applicability to diverse industrial fields such as smart city, smart factory, aerospace, sensor
- Implementation of high performance flexible PCB and 3D PCB through conductivity improvement of conductive ink
- Low-cost and quick PCB prototyping in the phase of product development
- Flexible electrode and 3D PCB have competitiveness to fulfill various demands, capable of small quantity-various kinds production, customizable production
- Quick product supply through process reduction from PCB design to production
- PCB manufacturing technology with plasma jet is advanced processing of eco-friendly production environment and personnel safety
- Plasma jet makes it easy to recycle defective PCB of the existing PCB process, reducing the waste and recycling resources.

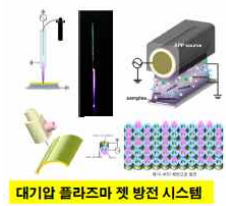
< Technology Overview >

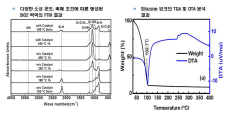


<Plasma jet nozzle>



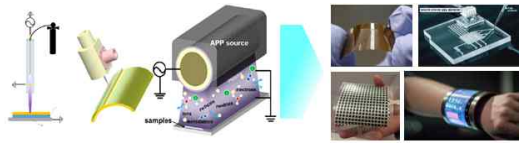
<Patterning 3D printer>



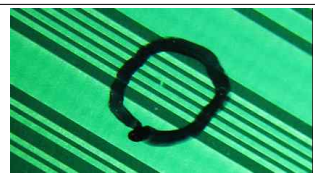


<Inc characteristic analysis>

< Applicable range and area >



<Ease of PCB manufacturing>



<Defective PCB in the manufacturing process (top) and PCB recycling(bottom)>

[Target area and plans for overseas expansion]

○ Plasma + 3D printing technology development for PCB repair

- As patterning method with conductive ink and atmospheric plasma, it aims to construct business strategy based on data after building track record through collaboration with other companies, using small quantity-various kinds production by shortening processes

- Surface reforming is a world-growing business, and our technology has various development plans, enabling surface reforming without damage to devices through nozzle with precision of atmospheric plasma

- Plans for PCB repair module development with conductive ink patterning technology are as follows

(Conductive ink exclusive for PCB repair)
- New business model through development of exclusive conductive ink for PCB repair, optimized for PCB, through diverse experimentations and tests of load, resistance of conductive ink

(PCB repair conductive patterning module)
- Product reliability by increasing PCB repair efficiency and securing accuracy through development of PCB repair conductive patterning module with plasma jet

(PCB repair module control actuator and bed)
- Optimal condition through consistent check in accuracy and promptness of actuator to control modules besides PCB repair module and PCB replacement bed accuracy and precision such as width of printed circuit and gap between circuits are of high importance in PBC repair equipment

(PCB repair equipment with conductive ink)
- Accurate and quick PCB repair equipment development through optimized control of developed module, actuator to be developed, and bed

○ High strength metal 3D printing technology development with induction heating

- Technology development for optimization of material and processing technology for DME

- High strength Aluminium alloy filament development for DME

- 3D printing process module development with DME

- 3D printing process optimization with DME

- Applicability assessment of 3D structure parts

- Performance and usability assessment of developments