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EUROPEAN NETWORK OF RESEARCH AND INNOVATION CENTRES AND HUBS, CHINA

Create a new era of large size additive manufacturing technology

Weichuang 3D printing innovation center

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EUROPEAN NETWORK OF RESEARCH AND INNOVATION CENTRES AND HUBS, CHINA

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1.

Maintain the leading position of aerospace manufacturing technology through 3D printing technology

1. Maintain the leading position of aerospace manufacturing technology through 3D printing technology

On May 5, 2020, China's first successful launched Changzheng No. 5B carrier rocket was equipped with a "3D printer". During the flight, it independently completed the sample printing of continuous fiber reinforced composite materials, and verified the scientific experimental goal of 3D printing of composite materials in microgravity environment. This is the first time that China has carried out the orbital 3D printing experiment, and it is also the first time in the world to realize the space 3D printing of continuous carbon fiber reinforced composite materials.

At about 12:41 on July 23, China's Tianwen No. 1 Mars probe, which was carried by China's Changzheng No. 5B carrier rocket, installed and used customized 3D printing parts, including a considerable part of metal 3D printing parts (titanium alloy, etc.). With its high strength, high temperature resistance, radiation resistance and other high-performance characteristics, it can meet the requirements of normal operation in the harsh environment of Mars.

3D printing has significant advantages in aerospace applications, including: shortening the research and development cycle of new aerospace equipment, improving the utilization rate of materials, saving expensive strategic materials, reducing manufacturing costs, improving design freedom, optimizing part structure, reducing weight, reducing stress concentration, increasing service life, making parts easier to be repaired, etc. Take the aviation field as an example, by reducing the structural weight of 1kg, the additional weight of 4kg can be reduced, and 45000 liters of fuel can be saved in the whole operation life of the aircraft, and the cost can be saved by 29,000 euros. On the one hand, advanced materials with lighter weight and stronger performance are used to replace the existing materials. The other is to carry out lightweight design of existing aircraft parts based on 3D printing, including hollow sandwich, hollow lattice structure, integrated structure and special topology optimization structure. Airbus, for example, has installed more than 1000 3D printing parts on its A350 XWB aircraft. It is estimated that Boeing has used about 60000 3D printing parts for the aircraft so far.

Metal 3D printing technology can manufacture lightweight, new materials, special structure metal parts, shorten the development cycle. At present, the size of metal parts is breaking through the ceiling again and again, moving towards printing larger size parts or even whole machine manufacturing. And these large parts are often used in the country's top important equipment.

The advantages of 3D printing are becoming more and more prominent in the field of private aerospace. In foreign countries, Blue Origin uses 3D printing technology to print the shell, turbine, nozzle and rotor of BE-4 rocket engine; NASA realizes the most complex rocket parts through 3D printing, and uses 3D printing technology of selective laser melting to produce turbine pump, which reduces raw material consumption by about 45% compared with traditional welding and assembly technology. Germany's Fraunhofer IWS has unveiled an additive manufacturing-3d printing plug nozzle engine, which is used in microsatellite launchers with a payload of up to 350 kg. Compared with the traditional design, this engine has obvious advantages in light weight and fuel saving.

Domestic OneSpace, Deep Blue aerospace, SPACEFLIGHT LEADER, Qiancheng technology and other new generation aerospace enterprises are also making continuous breakthroughs in the application of 3D printing. Among them, Deep Blue aerospace has optimized the design of the main functional components, and achieved a technological leap of 95% to 99% of the domestic LOX kerosene rocket engine thrust chamber efficiency. BLT ‘s extra-large size metal additive manufacturing equipment that undertakes this task, and completes the metal 3D printing work of the injector shell and the thrust chamber body of the test engine respectively.

At the same time, the structure of Qiancheng-1 satellite, which has completed the mission, adopts the lightweight three-dimensional lattice structure design method for additive manufacturing, and finally realizes the printing and forming by using BLT’ s extra large size metal additive manufacturing equipment.

By comparing the traditional technology, we can see that the weight proportion of the whole satellite structure of Qiancheng-1 microsatellite realized by 3D printing is reduced to less than 15%, the whole satellite frequency is increased to 110hz (the traditional microsatellite structure weight accounts for about 20%, and the whole satellite frequency is generally about 70Hz), the number of components of the whole satellite structure is reduced to 5 pieces, and the design and preparation cycle is shortened to 1 month. The whole satellite structure size is more than 500mm × 500mm × 500mm envelope size, which is also the largest additive manufacturing integrated satellite structure.

2.

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In fact, large size has always been an important direction in the development of metal additive manufacturing equipment. Larger forming size can significantly expand the application scope of metal additive manufacturing technology, solve the difficulties and pain points in the traditional manufacturing process of large-scale complex components, and realize the mass production of small and medium-sized complex components, and provide the advanced technology solution of short process, digitization and controllable quality.

In March this year, Xi'an BLT Additive Technology Co., Ltd., a leading enterprise of 3D printing in China, launched the large format laser selective melting equipment blt-s450 (three configurations of single laser, double laser and four lasers can be selected). This application of 3D printing additive manufacturing technology in aerospace fluid power field with large size, complex structure and high-performance components and the R & D and upgrading of domestic additive manufacturing equipment has been further advanced. It is especially suitable for the research and development needs of large-size components in aerospace field, such as long forming time, high reliability requirements, etc., and meets the requirements of large-scale, complex curved surface precision structure forming and high working conditions of key components of large thrust heavy-duty carrier liquid rocket engine, and can enable the high-quality development of aerospace fluid power field.

Blt-s450 is also a metal additive manufacturing integrated system for the future intelligent factory. Its core technology and application value are in the world's advanced level. The blt-s600 (forming size is 600mmx600mmx600mm) launched in June this year is the first large-scale, four laser metal additive manufacturing equipment with three-way forming dimensions exceeding 500mm in the world. This is also a process of continuous accumulation: as early as 2016, BLT has started the development of unidirectional forming equipment with a size of more than 500mm. It has successively broken through the key technologies such as four beam linkage scanning and splicing, and has continuously cultivated in intelligent software for forming quality control; BLT has always believed that the key factor to test large-scale metal additive manufacturing equipment is whether the equipment can ensure long-term stable operation, high-efficiency continuous production and excellent internal and external quality control of forming parts. Therefore, BLT has never stopped the research and development of the process and its application performance improvement, so as to promote the development of the industry towards higher performance equipment and application level. Before each new model is launched, BLT has to ensure that after more than 40000 hours of product printing and measurement, several rounds of program design iterations, nearly 50 times of detail correction, and the single non-stop operation time of the equipment exceeds 1000 hours.

BLT power launched blt-s510 on August 25, 2020, and successfully printed 400 mm x 400 mm x 780 mm titanium alloy aero-engine blades, and 4.2 kg aluminum alloy guide rail bracket with the size of 327 mm x 317 mm x 360 mm and the weight of 4.2 kg. Taking titanium alloy aero-engine blade as an example, through blt-s510, a metal 3D printing device, based on the prototype optimization design of aero-engine hollow blade, BLT made the internal hollow fan blade form at one time. Compared with traditional machining, the processing cycle is shorter and raw materials are saved. After two years of ingenious design, five years of experience and production verification of more than 20 sets of equipment, BLT blt-s510 has reached the level of domestic and foreign advanced products in the core technical indicators of forming size, lamination thickness, laser power and quantity, maximum scanning speed, repetitive positioning accuracy, preheating temperature, oxygen content control, powder spreading efficiency and other core technical indicators; its products have passed the important aerospace quality certification; it has a number of independent research and development software technology functions to ensure the forming quality and stability of the equipment; compared with many similar enterprises with large-scale forming but without production verification, the biggest advantage of BLT is that it has accumulated rich production experience and process parameter experience after a long time of verification of various parts structure and types. And have professional and international testing ability. BLT Testing Center for metal material chemical composition analysis, material mechanical properties testing, microstructure testing, geometric testing, X-ray testing, fluorescent penetrant testing and other testing items. Among them, material testing, non-destructive testing, heat treatment and measurement inspection have been certified by NADCAP, which shows that the special process, inspection and testing technology level and standard management of the BLT additive manufacturing equipment are in the international level.

In addition, BLT blt-s510 also has a unique self-developed multi galvanometer control system and quality traceability system. The multi galvanometer system realizes the cooperation of multiple galvanometers to minimize the forming size error of the lap joint, and the melting quality of the lap joint is equal to or better than that of the single galvanometer printing area. The quality traceability system includes high-definition camera, sensor, grating ruler, database software, etc., which can realize the real-time monitoring and recording of printing process, and ensure the traceability of the whole printing process of parts. The HD camera installed on the top of the equipment can take pictures and save the printing state and powder laying state of each layer. By observing the saved photos, the status of all printing layers of parts can be checked, so that various defects such as pore defects, crack defects, blowing defects, printing defects can be identified in the printing process, so as to effectively ensure the high output value and high yield of the equipment stability. In addition, the equipment also carries the standard functions of blt-mcs software independently developed by BLT, such as synchronous light output, automatic galvanometer splicing, fault intelligent diagnosis, intelligent powder adjustment, etc., and can also be equipped with scanning quality detection and blt-mes system to help users realize customized intelligent management.

Based on this, Dr. Xue Lei, chairman and general manager of BLT, said in an interview with guangming.com that "the materials, equipment and processes of metal 3D printing are coupled and indispensable. What users need is often a comprehensive solution that integrates the elements of equipment, technology, materials and design. Deep ploughing materials, self-developed equipment, constantly improve service ability, layout the whole industry chain, better combine high-level service ability with equipment, package and form high-performance price solution, and provide "turnkey" one-stop solution for equipment users

The 3D printing metal additive equipment and manufacturing, represented by BLT, will be reformed and innovated. Every technical breakthrough will inspire the ambition and ambition of design, technology and manufacturing. As a bright pearl in the industrial crown, aerospace manufacturing field integrates all the high-end technologies of a country to implement the national strategic plan. As an important manufacturing technology, metal 3D technology will further bloom in the aerospace high-end manufacturing field with the continuous development of material technology, computer technology and laser technology the powerful power of wielding country's top important equipment. Let's wait and see.

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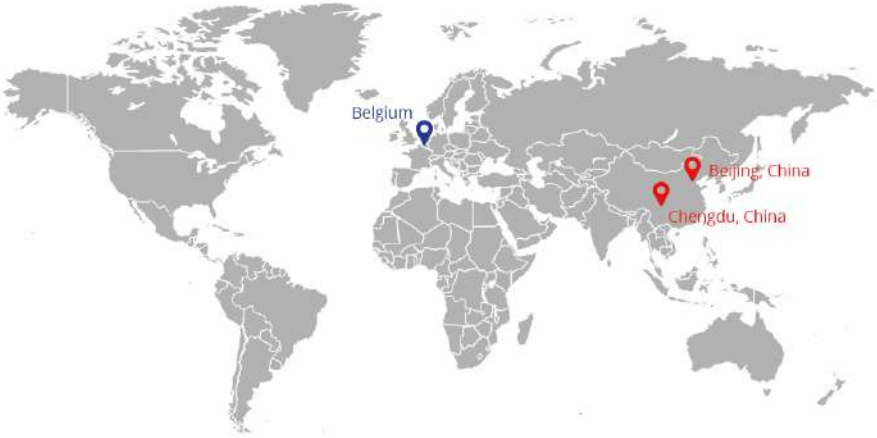

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