Research Status and Development Trend of Advanced Manufacturing Technology for fuze

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Abstract. This paper analyzes a series of problems which need to be solved for a long time in China's fuze manufacturing industry, such as high resource consumption, poor economic benefit, low technology content, mostly in the low end of the industrial value chain, and points out that advanced manufacturing technology can promote the transformation and development of China's fuze manufacturing industry. Based on the brief introduction of the concept, development history and key technologies of advanced manufacturing technology, this paper focuses on the application background, theoretical research and engineering progress of micro nano structure precision machining technology, intelligent additive manufacturing technology, intelligent manufacturing system and industrial internet. It is proposed that China should take "made in China 2025" as the traction, vigorously develop advanced manufacturing technology, and promote the sustainable, green and healthy development of China's manufacturing industry.

1. Introduction
Manufacturing industry is still a powerful engine to promote China's economic growth, but the overall situation of China's manufacturing industry is still not optimistic. From the perspective of resource utilization and environmental protection, China's manufacturing industry consumes a lot of energy and resources, and causes serious environmental pollution; from the perspective of scientific and technological innovation and manufacturing technology level, China's manufacturing industry has relatively weak scientific and technological innovation ability, low scientific and technological content, relatively backward overall technical level, fewer products with independent intellectual property rights, and low added value of products; From the perspective of industrial value chain, most of China's manufacturing industry is in the lowest value creation link of value chain (R & D, manufacturing, marketing). In the field of R & D and marketing, scientific and technological innovation ability is weak, and brand building is insufficient; from the perspective of manufacturing market, the market competition in the era of knowledge economy is more intense, consumption is more personalized, and the purpose is to pursue production efficiency It is difficult to adapt to the personalized and diversified needs of customers in the modern market [1-2]. In order to improve the overall level of China's manufacturing industry, promote the transformation and development of China's traditional manufacturing industry to modern manufacturing industry with international competitiveness, and ensure national economic security, China put forward the "made in China 2025" plan. "Made in China 2025" is a strategic
document deployed by the State Council to comprehensively promote the implementation of manufacturing power, and is the first ten-year action program for China to implement the strategy of manufacturing power.

"Made in China 2025" puts forward important strategic tasks, such as improving the innovation ability of national manufacturing industry, promoting the deep integration of informatization and industrialization, and comprehensively implementing green manufacturing. Advanced Manufacturing Technology (AMT) is an important technical foundation and support to realize this series of strategic tasks. Advanced manufacturing technology pays attention to the integration of economic benefit and technology. It has the characteristics of high product quality, high technology content, low resource consumption, less environmental pollution and good economic benefit.

2. The concept and development history of advanced manufacturing technology

Manufacturing refers to the process of processing or reprocessing raw materials and assembling parts. The concept of Advanced Manufacturing Technology (AMT) originated in the United States, and its early definition was a manufacturing technology group based on computer and information technology, mainly including computer-aided design, computer-aided manufacturing, computer-aided engineering, robot and flexible manufacturing technology, automatic control system, numerical control technology and equipment, etc. Advanced manufacturing technology has different meanings in different times. At present, advanced machining technology (such as micro nano structure precision machining technology, intelligent additive manufacturing technology, high-speed cutting technology, etc.), concurrent engineering, flexible manufacturing system, virtual manufacturing technology, agile manufacturing technology and modern intelligent manufacturing system, etc., all belong to the research scope of advanced manufacturing technology [4].

3. Research progress on advanced technology of fuze manufacture

3.1. micro / nano structure precision machining technology

Parts can be divided into different types from different angles, as shown in Table 1[5,12]. Different types of cross combination constitute high-performance parts with integrated structure and function.

| Classification by material | Classification by structure |
|---------------------------|-----------------------------|
| Single material composition | Simple macro structure |
| Connection of various materials | Macro meso scale structure |
| Composite formation of various materials | Various microstructures |

Complex micro / nano structured surface is a kind of functional surface with multi-level and multi-scale periodic structure, whose main characteristic size is between tens of nanometers and tens of microns, which has great development prospects in many fields. The performance and index requirements of micro / nano structure, such as desorption, drag reduction, hydrophobicity, noise reduction, wettability, sealing, high specific surface area, surface energy, surface work, high photoelectric conversion efficiency and high reaction sensitivity, sometimes need to be realized by constructing the micro structure surface of devices. In addition, many physical phenomena of micro nano structure are different from macro scale. Therefore, it is necessary to explore the basic theory and technology of micro nano structure manufacturing. The difficulties in manufacturing parts with micro / small and micro / nano cross-scale structures lie in the new principles and methods of large-scale and batch cross-scale structure manufacturing, as well as the compatibility of scale, material and manufacturing process of cross-scale structure [5]. For example, Oxford Lasers had commercialized the machining of micro shaped holes using femtosecond laser, as shown in Figure 1[6].
In recent years, the manufacturing technology of micro / nano structures has made remarkable progress. According to the effect of specific parts, micro nano structure processing has been successfully applied in space detector, laser detector, anti-counterfeiting trademark, torpedo, aircraft fuselage and biochip. Due to the complexity of the relationship between micro / nano geometric structure and parts performance, many new interdisciplinary subjects are involved [5]. For example, Zhang Qiu [7] proposed an Exploding Foil Initiator (EFI) based on Low Temperature Co-Fired Ceramic (LTCC) with microstructure for fuze, as shown in Figure 2.

At present, the research at home and abroad focuses on different materials, surface structure forms and application occasions. For the fabrication of high-performance geometric and micro structural surfaces, it is sometimes necessary to carry out special research on microfluidic, micro friction, micro heat transfer, micro optics, micro nano solid mechanics, micro nano fracture mechanics and so on for the specific objects of wall adhesion, viscous dissipation and fluid wall slip. So far the friction resistance is reduced by controlling the flow characteristics of the boundary layer, and the technologies such as constructing micro ribs, pits, grooves, zigzag texture, micro pin array drag reduction and local addition of rough band to delay transition have emerged [5,8,12].

In order to break through the limitations of current machining methods for machining complex micro / nano structures, Zhu Zhiwei [9] proposed a new method of diamond milling servo machining complex optical surfaces (such as laser detector optical glass) by combining the advantages of tool servo turning and flying cutter milling.

3.2. Intelligent additive manufacturing technology
Additive manufacturing technology is the integration and innovation of material technology, bonding technology and printing technology. The parts made by the near net shape forming technology, which is directly manufactured from raw materials to precision workpieces, can be put into use without machining or a small amount of processing, which greatly improves the traditional blank forming
technology. Driven by the progress of new material technology and laser technology, additive manufacturing technology is rapidly penetrating from traditional consumer goods and teaching experimental equipment to new fields such as medical devices, automobiles, aviation, etc. In addition to using additive manufacturing technology to manufacture soft tissues such as crowns, knee bones and artificial noses, medical device companies have begun to produce liquid vaccines combined with biological structure analysis technology. At present, additive manufacturing technology can complete the internal structure and three-dimensional shape of parts at one time. Besides, it has been able to manufacture large-scale metal parts with several meters in length. However, there are still some deficiencies in stress control, density, surface roughness and intelligent molding. In particular, the precision of forming process has not reached the level of precision machining. For example, the precision of three-dimensional molding of fuze micro parts still can’t meet the design requirements. It is necessary to explore new forming methods and composite technology. Wu used femtosecond laser to fabricate 3D polymer micro/nano structure in 3D glass microfluidic channel to realize a microbial chip based on the concept of "ship-in-a-bottle", as shown in Figure 3[6].

![Figure 3. High precision 3D polymer microstructures in 3D microchips](image)

In view of the above shortcomings, Liu Tingting [10] carried out research on the application of intelligent additive manufacturing technology in aerospace, mainly including intelligent design of additive process and equipment, optimal design of mechanical topology, intelligent process constraints related to additive manufacturing, density morphology optimization of lattice structure under multiple load constraints, intelligent planning of process path based on feature recognition, and so on. Intelligent online monitoring and feedback regulation system.

3.3. Research on fuze intelligent manufacturing system and industrial Internet

Fuze manufacturing system is an effective production mode and a certain production organization form to improve product quality, market competitiveness, production scale and production speed to complete specific production tasks. The intelligent manufacturing system is based on information technology, intelligent technology, numerical control technology and so on. It uses advanced manufacturing technology to organize the manufacturing process in a flat, networked and digital organizational structure. Industrial internet reconstructs global industry by connecting intelligent machines and man-machine with software and big data. In addition, it can help the manufacturing industry to elongate the industrial chain and form cross equipment, cross system, cross factory and cross regional interconnection, so as to improve efficiency and promote the intelligence of the whole manufacturing service system.

Wang Huifen [11] carried out the application research of intelligent manufacturing system and industrial Internet. In essence, intelligent manufacturing technology and industrial Internet are inseparable. It realizes the intellectualization of product design, manufacturing, logistics, management, maintenance and service through perception, human-computer interaction, decision-making, implementation and feedback. From the equipment controlled by the program to the intelligent control, it can self-adaptive feedback the status of the workpiece in the process. The application of industrial internet in fuze intelligent manufacturing system can effectively manage manufacturing resources, monitor manufacturing process and match manufacturing requirements. The industrial internet can not only coordinate the optimal operation of material flow, energy flow and information flow in the fuze manufacturing process, but also support the intelligent design of products, the automation of production process and the accuracy of supply chain control. Finally, the industrial internet can improve the
competitiveness of fuze manufacturing enterprises.

4. Conclusions
In summary, at present, the field of advanced manufacturing technology is mainly composed of two parts: one is the advanced manufacturing technology transformed from the traditional manufacturing technology integrating and absorbing advanced technology (such as information technology and advanced material technology), such as intelligent manufacturing system and industrial Internet; the other is the new technology formed by the application of the achievements of major scientific and technological innovation, such as micro Nano structure precision machining technology, additive manufacturing technology, etc.. The new generation of artificial intelligence, Internet of things, advanced materials, new energy and other new technologies are rapidly forming an industrial scale market, which is conducive to the development of circular production and circular economy in China and the realization of economic, environmental and social benefits. The balanced development of benefits. The future fuze manufacturing system in China should be more based on advanced manufacturing technology to promote the sustainable, green and healthy development of China's fuze manufacturing industry.

Acknowledgments
This paper was supported by Jiangsu Postgraduate Research Innovation Program (SJKY19_0298).

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