

Exploration on the transformation mode of scientific and technological achievements in new R & D institutions——Take Guang Dong Hong Kong Macao Dawan District National Nanotechnology Innovation Research Institute as an example

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Abstract: At present, China's new R & D institutions have stepped up their construction and vigorous development, become an important force in the regional innovation system, build an important bridge for the transfer and transformation of scientific and technological achievements, play an important role in promoting the transformation of high-level research achievements of colleges and universities and scientific research institutions into industry, and promote the continuous improvement of level 1-9 scientific and technological innovation chain. Guangdong Province has vigorously cultivated and developed new R & D institutions, actively explored the transformation mode and path of scientific and technological achievements, and formed a number of specialized, market-oriented and characteristic new R & D institutions in key industrial fields such as biomedicine and health, new materials, etc. Through the integration of political, industry, University and research resources and other resources, it focuses on promoting the achievement transformation and application of key core technologies in strategic emerging industries. With the wide application of Nanotechnology, the transformation of basic research achievements in the field of Nano-science and technology has ushered in a major opportunity, and the emergence of relevant new R & D institutions supporting the transformation of Nanotechnology achievements has accelerated. In this context, in Guangdong Hong Kong Macao Dawan District, where strategic emerging industries are developing rapidly, the National Nanotechnology Innovation Research Institute of Guangdong Hong Kong Macao Dawan district (hereinafter referred to as "Guangna Institute") was established as a new research and development institution focusing on the transformation and industrialized application of achievements in the field of Nanotechnology to explore new modes and paths for the transfer and transformation of Nanotechnology innovation achievements, actively promote the transformation of China's globally advanced and partially leading basic research achievements in Nanotechnology into innovative products, cultivate them into emerging industries, build a complete innovation chain of level 1-9 and create a good innovation ecology.

1. Development of Nanotechnology

1.1 Development Survey of Nanotechnology

1.1.1. Concept of Nanotechnology

Nanotechnology, information technology and biotechnology together constitute the three pillars of high and new technology in the world. It is recognized as one of the most important and fastest developing frontier fields. Nanotechnology is a method and means based on Nano-science to study the properties and applications of materials with structural scale in the range of 0.1-100 nm, make new materials, new devices and study new processes. Nanotechnology means the combined product based on the microscopic research theory of physics and chemistry and by means of contemporary precision instruments and advanced analysis technology. It is Dynamic Science (Dynamic Mechanics), Modern Science (Chaotic Physics, Quantum Mechanics, Mesoscopic Physics and Molecular Biology) and Modern Technology (Computer Technology, Microelectronics and Scanning Tunneling Microscope Technology, Nuclear Analysis Technology. Nanotechnology involves a wide range of scientific, technological and industrial fields. Its application in the fields of energy and environment, biomedicine, information devices and green manufacturing has become increasingly prominent, and has become an important source of revolutionary industrial manufacturing technology. Nanotechnology has the characteristics of foundation, high intersection and high penetration. The application of Nanotechnology to develop Nanotechnology industry is of great significance to improve the industrial scientific and technological innovation ability and promote the transformation and upgrading of traditional industries. Due to the Enabling effect of Nanotechnology on traditional and emerging industries, the attribute of "Nano +" is prominent.

1.1.2. Industrialization process of Nanotechnology

The industrialization of Nanotechnology in China has mainly experienced three stages: the Embryonic period (1995-2002), the Transformation period (2003-2007) and the Take-off period (2008 - present). From 1995 to 2002, Nanotechnology enterprises began to be established, mainly Nano-powder material enterprises, to promote the large-scale production of Nano-powder materials and gradually promote the penetration of Nanotechnology into the industry; Since then, the development of Nanotechnology industrialization has entered a transition period. After going through the early market baptism, enterprises realize that the production of powder materials alone is far from enough, and the downstream product application needs to be considered. During this period, the number of enterprises engaged in the production of Nano-powder materials decreased, while the number of enterprises engaged in the application of Nano-materials increased significantly, but it is still dominated by traditional industries; In 2008, Nanotechnology enterprises entered a stage of rapid development. Enterprises applying Nanotechnology in information, biomedicine, energy and environment mushroomed and created huge economic benefits. Subsequently, during the 12th Five Year Plan period, China's Nano-industry changed to agglomeration development, and began to form an integrated development model of "official, industry, University, research and application".

1.2 Development of Nano industry

1.2.1. Concept of Nano industry

It is generally believed that Nanotechnology related industries will be formed when Nanotechnology application products realize batch, commercialization and scale. Specifically, Nano-industry refers to Nanotechnology and its related industries, which has the characteristics of interdisciplinary and cross industry. The upstream of Nano-industry involves many disciplines such as material physics, material chemistry, electronics, biology and clinical medicine. The core links in the middle reaches mainly include Nano-material, Nano-device, Nano-detection and characterization and standards, which are manufactured through Nano processing, and all links are closely related. Among them, Nano-materials are the original basis for the existence and development of nanotechnology related industries. Nano devices are the products of further processing and combination of Nano materials and the basis for the extended development of various nanotechnology application products. Nano-detection instruments and processing equipment are the indispensable hardware support for the development of Nano materials, devices and extended products. Nano materials and Nano devices are applied in various emerging and traditional industries, integrated with biomedicine and health, electronic information, energy and environment, intelligent manufacturing and other industries, extended to form new industries and new business forms such as Nano-biomedicine, Nano-energy and environment, Nano-intelligence and gave birth to diversified Nanotechnology products.

1.2.2. China has Made Remarkable Achievements in some Fields of Nano-industry

In the past decades, China has made remarkable achievements in the fields of coatings, printing inks, dyes, adhesives, fiber materials and textile processing technology, Nano-drugs, biological effects of Nano-materials, Nano-particle self-assembly, carbon nanotubes, Nano purification materials, semiconductors and so on. For example, Hefei Meiling Group began to develop Nano-refrigerators in 1996, using Nano-antibacterial coatings to prevent moldy door seals of foldable PVC magnetic refrigerators; China has successfully prepared the world's longest carbon nanotube with a single length of more than half a meter; Man made fiber is the development trend of chemical fiber and textile industry. China's textile occupies a favorable position after entering WTO, and the application of nanotechnology has contributed some strength; the power industry uses nanotechnology to transform 200000 V and 110000 V voltage transformation and transmission porcelain bottles, which can comprehensively improve the electric shock resistance of 110000 V porcelain bottles, and the glaze does not frost.

In the future, Nanotechnology, rice noodles, Nano-functional plastics, Nano-functional coatings, advanced hydrogel materials, environmental protection, energy, information and electronics, biological and medical, aviation and military industries will further achieve technological or market breakthroughs through the application of Nanotechnology.

1.3 The Conversion Rate of Nano-Achievement is not high

1.3.1. China Leads the World in the Number of Basic Research Papers and Patent Applications in the Field of Nanotechnology

Nanotechnology is one of the few scientific and technological fields in China that can run side by

side with the United States and partially lead. The number of high-quality basic research achievements published in Science, Nature and sub-journals in China has surpassed the United States and ranked first in the world; The academic influence of China's Nano-literature has increased significantly. The FWCI of China's Nano-literature has increased from 1.3 in 2000 to 1.9 in 2019, an increase of 43%, and surpassed that of the United States in 2019. China has an absolute advantage in the number of nano related patents. From 2000 to 2019, the number of patents in the field of nano technology in China was nearly 310000, accounting for 45% of the world.

1.3.2. China has a Strong Basic Research force in the Field of Nanotechnology

With the support of various science and technology projects in national provinces and cities, the basic research conditions of Nanotechnology in China have been continuously improved, a professional team engaged in nanotechnology research has been trained, and a number of research teams with world leading level have been created. So far, 121 scholars engaged in nanotechnology research have been elected academicians of the two academies. They are a powerful advanced scientific and technological force and play an important leading role in more and more international cooperation.

1.3.3. The Patent Rate of Nanotechnology Industry is Low

Although the basic research of Nanotechnology in China has been in the leading position in the world and has accumulated a large number of basic research results, the conversion rate of Nanotechnology achievements is very low, less than 1 / 10 of that in the United States. Moreover, the number of patent applications accounts for 45% of the world, but the patent competitiveness still needs to be improved, and the industrialized application of Nanotechnology still faces a series of development problems. The talent structure of Nano-industry in China is unbalanced, and there is a lack of engineers engaged in Nano-industry engineering. The cultivation of various talents urgently needed for the transformation and industrialization of Nanotechnology achievements is insufficient, especially the lack of talents familiar with Nanotechnology industrialization, product sales and management, which can not effectively support the rapid transformation of Nanotechnology achievements into products.

2. Exploration on the Transformation of Nanotechnology Innovation Achievements of Guangna Institute

2.1 Implement Market-Oriented Operation Mechanism

Guangna Institute has implemented market-oriented operation, established an organizational structure and management system with market competitiveness, and adhered to solving the problem of the last mile of achievement transformation in a market-oriented way. For the introduced industrialization project, Guangna Institute participates in the industrialization transformation of the project through market players such as Guangdong Guangna Development Technology Co., Ltd. and Nano Valley (Guangdong) Technology Group Co., Ltd., connects and introduces various market and channel resources, promotes the close integration of scientists and entrepreneurs, improves the matching degree of market demand for project achievements, accelerates the transformation of scientific and technological achievements into products for market sales, forms market competitiveness and explores the development path of new R & D institutions to realize

"self-hematopoiesis", promote the diffusion, flow, sharing and application of scientific and technological achievements through market-oriented means, and realize economic and social values.

2.2 Supplement the Level 4-6 Short Board of Scientific and Technological Innovation Chain

Guangna Institute aims at a large number of basic research achievements accumulated in the field of nanotechnology in China, provides corresponding platform resources, deploys the innovation chain around the industrial chain, quickly gathers the key elements needed for technology commercialization, actively promotes the transfer and transformation of scientific and technological innovation achievements, gives full play to the engineering ability of high-quality craftsman talent team, effectively ensures the level 4-6 transformation of scientific and technological innovation chain, focuses on promoting the industrialization of a number of R & D projects in the core links of the Nano-industrial chain, completes many complex engineering and systematic work from level 1-3 laboratory achievements to level 7-9 industrialization, effectively links the basic scientific achievements and industrial technology application in the field of Nanotechnology, and builds a complete level 1-9 scientific and technological innovation chain in the field of Nanotechnology.

2.3 Innovating the Transformation Mechanism of Scientific and Technological Achievements

In order to realize the efficient transfer and transformation of scientific and technological innovation achievements, combined with the characteristics of cross integration of nanotechnology and multi disciplines, Guangna Institute explored and established a three-level intellectual property management architecture system, and built a high-level intellectual property team with clear structure and reasonable division of labor. At the same time, they will explore taking alliances and associations as an important starting point to connect the key elements of the transformation of intellectual property achievements, promote the transformation of intellectual property achievements, explore the construction of an intellectual property operation center, promote the transformation, operation of patents, the application of intellectual property, and build a benchmark for the efficient operation of intellectual property in China's strategic emerging industries.

2.4 Build Collaborative Innovation Network

Guangna Institute plays a major innovation platform role and constantly expands new modes of joint innovation and cooperation. Through the linkage of innovative resources such as upstream and downstream enterprises, scientific research institutes, innovative talents and industrial capital of the Nano-industry, explore and establish a collaborative innovation network with the joint efforts of "government, industry, University and research resources". Guangna Institute opens professional software and hardware resources such as scientific research equipment, pilot production line, testing instruments and supply chain channels for the introduction and incubation of Nanotechnology industrialization projects, supports the project team to carry out R & D of key core technologies and public application technologies, and speeds up product R & D and listing.

2.5 Upgrading and development of enabling industries

Guangna Institute focuses on the frontier fields of Nanotechnology, actively promotes the connection with downstream application enterprises of Nanotechnology, leads industrial development through Nanotechnology innovation and application, and promotes the upgrading and

development of strategic emerging industries such as the new generation of information technology industry, biomedicine and health industry and advanced material industry. In view of the technical needs, neck technology and development pain points of high-tech enterprises in innovative product iteration, Guangna Institute can provide engineers in the field of Nanotechnology, provide support in technology research, evaluation, testing, certification and other platforms, promote the training of new products and new business forms, realize the enabling development of Nanotechnology and support the upgrading of regional strategic emerging industries.

3. Problems in the Achievement Transformation of new R & D Institutions

3.1 Absence of Management Incentive Mechanism in new R & D Institutions

In the process of docking scientific research achievements with the market and successful transfer and transformation, the scientific research team, as the finisher of intellectual property rights, can enjoy the right of income distribution of achievements. However, as a new R & D organization management team that also plays a key role, it is responsible for the market-oriented operation management and service project team of the organization. Because it does not directly participate in project R & D and transformation, it has no right to participate in income distribution. The lack of this mechanism leads to the Unbalanced Income Distribution of new R & D institutions, which is easy to cause the loss of management talents of new R & D institutions. In addition, the personnel strength of the project team will show strong R & D and weak market, which will make it difficult for scientific and technological achievements to enter the industrial chain, resulting in the transformation of scientific and technological achievements with half the effort.

3.2 The Assessment Indicators do not match the Orientation of the Transformation of Achievements of new R & D Institutions

At present, the evaluation of new R & D institutions is still biased towards the evaluation dimension of traditional scientific research institutes. Through this evaluation, it can not effectively guide the development of new R & D institutions to "modernization of management system and marketization of operation mechanism", achieve the effect of "promoting construction through evaluation", and do not match the responsibilities and positioning undertaken by new R & D institutions. For example, there is a lack of assessment indicators closely related to the transformation of achievements, such as the acquisition of external investment, the mass production progress of achievements into products, market competitiveness and profitability, and there is a lack of corresponding consideration for craftsman talents such as engineers and technical managers, which are essential for the transformation of scientific and technological achievements.

3.3 Lack of Flexible Introduction Mechanism of High-Level Industrialized Talents

New R & D institutions generally introduce a large number of high-end innovation teams for achievement transfer and transformation, but generally, the high-level talents of the team are faced with the problem of choosing one between the original unit and the new R & D institution. Because scientists need to take into account the connection between source innovation and R & D industrialization, they can not completely separate from the original unit and go full-time to new R & D institutions to carry out relevant R & D and achievement transformation activities. In addition, new R & D institutions face practical difficulties such as high-level talent evaluation, recognition of

scientific research and academic achievements, application of scientific research projects and so on.

3.4 Insufficient Enabling Application Scenarios of Nanotechnology

In the new economic era, users must participate in the R & D process of new technologies, but for high-tech products, it is not easy to find matching users and appropriate application scenarios. At present, the transformation of Nanotechnology achievements is facing such a dilemma. There are insufficient innovative scenes for new technology experience and new product application in the field of Nanotechnology, which makes it difficult for relevant products to enter the supply chain and realize market application. In most applications, Nanotechnology belongs to the bottom support of terminal products and the supply of upstream raw materials. Due to the lack of rich technology Enabling application scenarios, it is unable to expand and extend the high-end application of Nanotechnology in advanced manufacturing industry and accurately connect with the needs of downstream application enterprises.

4. Countermeasures and Suggestions

4.1 Optimize and Innovate the Mechanism of Talent Introduction and Education

Talent is the primary productive force, and the transformation of scientific and technological innovation achievements needs more professional and specialized talents. In order to promote the development of new R & D institutions, attract more high-end talents to start businesses with technology, teams and achievements, improve the success rate of transformation of scientific and technological achievements, and contribute to regional industrial and economic development, it is urgent to improve the flexible talent introduction mechanism, earnestly practice the employment concept of "not seeking all, but using", and focus on the high integration of talents and industry to promote the transformation of innovative achievements. New R & D institutions can explore joint training of postgraduates with colleges and universities, and jointly cultivate high-end scientific and technological talents through the linkage of science and technology, talents and teaching.

4.2 Innovative Incentive Policies Conducive to the Transfer and Transformation of Scientific and Technological Achievements

Support and guide the owners of scientific and technological innovation achievements to quickly promote the transformation of achievements in new R & D institutions, implement the incentive policies for the transformation of scientific and technological achievements, give play to the platform role of new R & D institutions, and stimulate the vitality of innovation and entrepreneurship. Explore, improve and optimize the shareholding policies of scientific researchers, scientific and technological achievement "transformants" and operation managers, support the realization of scientific and technological achievement transformation, and the relevant personnel of scientific and technological enterprises established to obtain corresponding returns, so as to mobilize and stimulate the work enthusiasm of scientific and technological achievement creators and "transformants".

4.3 Explore and Implement the Negative List System

Implement the spirit of Several opinions of the general office of the State Council on reforming and improving the management of scientific research funds of the central government (Guo Ban Fa

[2021] No. 32), deepen the reform of "release, management and service" of scientific research funds, select new R & D institutions to pilot the reform of the "negative list" system of scientific research funds, optimize and simplify the approval process, and fully give new R & D institutions management autonomy to ensure that the use of scientific research funds is "open and manageable". Support qualified new R & D institutions to implement the "budget + negative list" management mode and improve the utilization rate of scientific research funds. Through the implementation of the negative list system, we can better aggregate scientific and technological resources, promote the transformation of achievements, solve the dilemma of "insufficient, bad and useless" scientific research funds, accelerate the pace of scientific and technological innovation, and effectively promote the rapid development of regional social economy.

4.4 Build new Product Verification Application Scenarios

Explore and implement the demonstration project of enabling application of new technologies and new products, and strive to create a number of enterprise benchmarks and typical application scenarios for innovative application of new technologies. Combine the application characteristics of cutting-edge and key core technologies in downstream industries to create a number of innovative benchmarking enterprises with industry representatives. Research and formulate relevant plans and scene lists for the development of nanotechnology application scenes. According to the idea of "enterprises raise needs, the government organizes and cooperates to build scenes", and the different application needs of various enterprises for modern engineering technology and key common technologies, we can cooperate with various forces to study and formulate professional scene construction schemes and build new technology enabling laboratories, the application test field and other scenarios which will provide a platform for the innovative application of new technologies in different scenarios.

2.5 Build an Enabling Sharing Platform

Give play to the core technology advantages of new R & D institutions and the enabling characteristics of relevant cutting-edge technologies, carry out joint innovation around traditional enterprises and new technology enterprises, promote the transfer and transformation of relevant technological innovation achievements, share industrial innovation resources such as technology, talents and scientific research equipment, and give new impetus to the transformation and upgrading of traditional industries. Explore the integrated innovation and application of new technologies in the field of strategic emerging industries, jointly carry out cross domain application, key research and industrialization cooperation, explore the innovation path and the combination mode of marketization and specialization of cutting-edge technologies to enable traditional industries, and give birth to a number of new business growth technology enterprises with integrated development.

2.6 Create an Inclusive Results Transformation Environment

As an important carrier for the transformation of scientific and technological innovation achievements, new R & D institutions connect cutting-edge technological achievements at one end and product application market at the other end. Through system and mechanism reform and innovation, they can efficiently build a channel from technology to industry, and form an innovation ecology in which all links of "government, industry, learning, research, capital and application" cooperate. Optimize the assessment and evaluation mechanism and index system of new R & D

institutions, make new R & D institutions "open and manageable", and provide a better environment for the industrialization of scientific and technological innovation achievements.

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