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The Promotional Role of Patent Information Analysis in Improving the Quality of Research & Development in Chinese Universities

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ABSTRACT
Colleges and universities are an important part of the national innovation system and an important supply side of technology achievements. Improving the quality of research & development (R&D) and patent applications in universities and enhancing the achievement transformation are urgent tasks. The R&D quality covers the quality of scientific research projects, R&D results and patented technology transformation. Patent quality includes the technical quality of inventions and patent application documents. Improving the R&D quality in Chinese universities requires great efforts. In this work, we attempt to explore promotional role in improving the R&D quality in Chinese universities from the perspective of patent information analysis.

Keywords: *Patent, Intelligence analysis, Colleges and universities, R&D quality.*

1. INTRODUCTION

In recent years, the amount of intellectual property in China has increased substantially and it has become a veritable intellectual property power. Statistics show that from 2007 to 2019, the number of valid invention patents in China has increased from 84,000 to 1.862 million. Universities have actively explored reform practices, and have achieved certain results in high-quality technology achievement, high-value patent cultivation, patent promotion and achievement transformation. The "2019 China Patent Investigation Report" showed that the level of patent application in Chinese universities is still relatively low. The effective patent implementation ratio of universities is 13.8%, the industrialization ratio is 3.7%, the licensing ratio is 2.9%, the transformation rate is 3.2%, and the price-to-share ratio is 2.0%, which are significantly lower than those of enterprises and research institutes. Among the unimplemented patents, considerable university patents are used for the purpose of completing patent review or assessment and obtaining awards, whose proportions are 56.3% and 41.6% respectively, indicating that the patent layout of in Chinese universities is highly influenced by policy factors. [1] The low quality of university patents is directly related to the low R&D quality. Colleges and universities are an important part of the national innovation system and an important supply side of R&D achievements. Compared with foreign high-level universities, Chinese university patents still have problems such as "emphasis on quantity and less quality", "applied less than implementation", [2] causing the loss of R&D achievements and failing to realize the value of innovation. Improving the quality of scientific research and patents, and enhancing the transformation and application of patents are urgent tasks that must be promoted.

At present, the evaluation of R&D quality in China mainly includes citation, appraisal and patent evaluation. Improving the R&D quality in universities should run through the entire process of R&D. In fact, the R&D quality is closely related to the R&D quality from the establishment of projects to the publication of papers, patent applications and the dissemination of innovative knowledge. At present, there are some domestic literature reports on improving the R&D quality and patents in colleges and universities, [3] [4] [5] basically from the perspective of macro policy, but there are few studies from the perspective of patent intelligence analysis. In this work, we attempt to start from the

perspective of patent intelligence analysis and explore its role in improving the R&D quality in Chinese universities.

2. IMPROVING THE R&D QUALITY PROJECTS THROUGH PATENT INTELLIGENCE ANALYSIS

All technological evolution is a gradual process, and any technological improvement may require years or even decades of unremitting efforts. Therefore, it is very important to study and understand the background technology or technological development process. Massive patents contain the most complete and up-to-date technical information in the world. Patent information analysis or technical document retrieval is the most effective means to know the technological development process. Scientific and technological information analysis is the process of discovering needs and the inevitable choice for finding innovation goals. Strengthening the entire process of patent intelligence analysis is also an inevitable requirement of "problem-oriented". Patent information analysis and technical literature search should be carried out before technology development or project approval. Valuable reference information can be obtained through search, so as to draw up a technical development route and determine the starting point of a research project.

Quantum dots (QDs) have widespread application in the fields of light-emitting diodes, lasers, photodetectors, information display and storage, solar cells and biological imaging, and are a hot spot in the field of novel semiconductor materials and device research. As a "disruptive technology", QD optoelectronic devices will set off a technological revolution in the information industry in the future, providing a good opportunity for Chinese information industry to break through foreign technology and patent blockade, occupy the commanding heights of industrial technology, and achieve "changing lanes and overtaking" opportunity. [6] Our university is one of the first institutions in China to study the synthesis and application of colloidal QDs. In recent years, when a certain research group applied for the project of the national R&D plan, in order to trace the development process of the technology, they had domestic and foreign patents in this field. Technical information was collected, and more than 3,200 patents were retrieved, covering QD synthesis and device preparation. Through the analysis of patent documents, the project team has mastered the international research frontiers and technological development trends in this field, improved the research route and technical solutions, and made the project research content richer and the expected goals more credible. The project team successfully passed the project review and obtained grants from the National Natural Science Foundation of China and National Key Research and Development Plan. They have published more than 10 high-level papers in international journals, and their research results have won scientific and technological awards from Hubei Province.

In the entire R&D process, it is also necessary to continuously update technical literature search and patent information analysis, and adjust the technical route, research plan and even research direction in a timely manner to provide decision support for the final R&D results to obtain intellectual property protection. Generally, patent quality is an important manifestation of the inherent R&D quality projects. The purpose of improving patent quality is to use and implement, and to promote the technology transformation. Both the application and transformation need to avoid the risk of intellectual property infringement. Infringement analysis and avoidance still depend on patent literature search. To improve the R&D quality in Chinese universities, we need to master the precise technological development process and background technology. Therefore, patent information analysis and technical document retrieval work are closely related to the R&D quality. Based on this, universities should establish and improve patent navigation work plans in the implementation of measures to improve the R&D quality, strengthen the importance of patent information analysis and technical document retrieval, and run them through the entire R&D process.

3. IMPROVING THE QUALITY OF PATENT APPLICATIONS THROUGH PATENT INTELLIGENCE ANALYSIS

On the one hand, improving the patent quality is of great significance to building a strong country with intellectual property rights. On the other hand, it is also a direct reflection of the level of innovation and is one of the core indicators that highlight the national innovation capability. Patent quality is based on the carrier of patent application documents, including patent claims, patent

specifications, etc., and is mainly determined by the level of patent technology and the writing level of application documents. Graf believes that patent quality can be understood from at least three different perspectives: the functionality and novelty of the subject of the invention, non-obviousness, and sufficient written description and support. [7] In the "Several Opinions on Further Improving the Quality of Patent Applications" in 2013, it is clearly mentioned that improving the quality of patent applications is of great significance to improving the level of patent protection of Chinese independent innovation achievements and ensuring the efficient operation of the patent system. [4] Therefore, improving the drafting quality of patent application documents is crucial to improving the patent quality. At present, the improvement of patent quality in terms of technical quality has been generally recognized by applicants, but the improvement of patent quality in terms of drafting quality of patent application documents has not received enough attention from applicants.

Graf believes that patent quality can be assessed from the perspective of validity and the inevitability of patent claims. For a high-quality patent, the specific features need to be clearly defined, and the patent claims should be maintained in subsequent legal proceedings as much as possible. [7] After analyzing the US university patents from 1965 to 1988, Henderson believes that the number of claims in the patent application text and the reference to the prior art play a vital role in the patent application. [8] Sampat et al. believe that the best patent application text is to know the existing technology from the beginning. When the applicant understands the best existing technology, he will write a patent application file with sustainable development. [9] Mann et al. believe that the applicant's patent search and analysis capabilities play an important role in improving the quality of patent applications, because the search capabilities enable the applicant to accurately identify the core of the patent-innovation. [10] Therefore, writing a high-quality patent application document requires a search and careful analysis of the technology in the existing patent information. Many applicants believe that patent search and analysis are the work of patent agencies and examiners, not the applicant's responsibility. Indeed, the examiner's job is to judge the innovation of patent application documents by searching existing technologies, but this happens after the patent application documents are submitted. Before the patent application documents are submitted, judging the degree of technical innovation is a link that cannot be ignored. In fact, patent search and analysis does not take too long, and the search elements are as comprehensive and accurate as possible to ensure that the existing technology can be locked more quickly. In particular, searching for keywords of "inventor or applicant" will be more helpful. The search database mainly locks several major patent databases at home and abroad, including the Chinese, the US, the European and the Derwent patent databases.

Memory is the core device of modern information technology. For a long time, this technology has been monopolized by the United States, Japan, South Korea and other countries. The scale of Chinese memory market has now exceeded 200 billion yuan, but due to the long-term lack of manufacturing technology with independent intellectual property rights, domestic memory production costs are extremely high, and Chinese researchers have been committed to breakthroughs in new storage technologies. China lags behind foreign countries in the field of dynamic random access memory (DRAM), so it is a wise choice to skip DRAM and directly develop phase change memory (PCM) technology. PCM mainly uses the difference in conductivity between the crystalline and amorphous states of reversible phase change materials to achieve storage, and is called a new type of memory that "manipulates the arrangement of atoms to achieve storage". PCM has many advantages, such as strong embeddable functions, excellent re-erasable characteristics, good stability and compatibility with CMOS technology. So far, no clear physical limit has been found for phase change storage (PCS). Studies have shown that when the thickness of the phase change material is reduced to 2nm, the device can still undergo phase change. Therefore, PCS is considered to be the most likely to solve storage technology problems, replace the current mainstream storage products, and become one of the new generations of non-volatile storage devices that are universal in the future. A research group of our university has been deeply involved in PCM for more than ten years and has achieved many independent innovations, and is preparing to apply for a series of patents on storage technology. In order to accurately grasp the technical information, legal information and domestic and foreign market information of patents in this field, they conducted a comprehensive search of international and domestic patent information, and retrieved more than 12,000 patents related to the technology. After systematic analysis,

they accurately grasped relevant domestic and foreign fields Based on the patent competition intelligence of technology, economy, law and strategy, the project team condensed its technical points, perfected the claims and technical descriptions, and significantly improved the quality of patent application documents. So far, the project team has obtained more than 90 high-value invention patents in China and the United States in the field of memory technology. In 2020, it transferred a well-known domestic chip company by way of ordinary license, and successfully realized technology transfer.

In addition, to improve the quality of patent applications and even patents, it is important to strengthen the exchange of patent information between patent information service agencies and applicants. For the completion of inventions and creations, to a certain extent, patent information service agencies and personnel play the role of intelligence officers. Applicants are the completers of inventions and creations. In the process of forming scientific research results, they have accumulated certain technologies reference. In communicating with patent information service agencies, these materials can be provided to service personnel, which is conducive to their comprehensive and accurate understanding of technical solutions, and avoids repeated searches. On the other hand, patent information service personnel have extensive patent knowledge background, and they can discover the defects in the invention and creation technical solutions in time when communicating with inventors. In addition, they can use their own experience and knowledge to help applicants improve their technical disclosure materials and invention scheme. In the communication process of patent applications, both parties can also use their own advantages and document information to help each other.

4. REALIZING THE RATIONAL PATENT LAYOUT THROUGH PATENT INTELLIGENCE ANALYSIS

Scientific literature retrieval and patent information analysis are of great significance for R&D by university researchers. Statistics show that although patent documents account for no more than 10% of all scientific and technological documents in the world, they provide more than 90% of the world's new technology information as long as the system searches for patents in five countries including the United States, Japan, Britain, France and Germany. The literature can understand 60 to 90% of the world's high-tech development. It can be seen that in R&D, full use of scientific and technological literature search and patent information analysis can scientifically and accurately grasp the technological development trend. The use of existing scientific and technological literature and patent information is a prerequisite to ensure the advancement of research and an inevitable requirement for high-quality research and development. At the same time, it can also be enlightened from the research process of predecessors and avoid detours. High-quality R&D has an important dependence on the existing patent information and technical literature. The so-called scientific research or technological innovation that is separated from the existing literature and information is a tree without roots and water without a source.

Scientific literature and patent information have the advantages of standardized content, large sample size, easy access, and easy measurement. The acquisition of scientific literature and patent information is mainly through databases. After the scientific and technological documents or patent documents are published, they are used as public information for researchers to read and use, among which patent application documents are the source of patent information. In a sense, the quality of patent application documents represents the quality of patent information.

Since the successful acquisition of graphene in 2004, various new two-dimensional (2D) materials have become a research hotspot in the field of advanced semiconductor research worldwide. 2D material and device technology has also become a patent highland seized by countries all over the world. As a kind of sp^2 orbital hybrid 2D layered material in which boron and nitrogen atoms are staggered, Hexagonal boron nitride (*h*-BN) has broad application prospects in the fields of information, biology, energy and advanced manufacturing. It has a lattice structure that is highly similar to graphene, and the difference in lattice constant is only 1.5%. However, unlike the semi-metallic graphene, *h*-BN is the only insulator material among all known 2D materials. It has no dangling bonds, no charge traps, and an atomically flat surface. It is considered to be the most important feature of the idealized substrate and channel insulating layer materials in graphene electronic devices is their interlayer stacking

structure. Most of *h*-BN materials belong to the AA' stacking structure, which is designed and prepared to characterize different *h*-BN nanostructure is one of the important research fields in recent years. A research group of our university started research on *h*-BN nanostructures in cooperation with the Chinese Academy of Sciences 10 years ago. Five years ago, it considered the patent layout of *h*-BN materials and nanoscale structures at home and abroad. Searching the domestic and foreign patent technology information in this field, a total of nearly 5,000 related patents of *h*-BN were retrieved. After these patents were systematically analyzed by the main inventor, technical field and technological evolution, and the country where the patent is located, they made judgments and predictions on the technological development trend in this field. They took a different approach, starting from *h*-BN nanoscale heterostructure, using metal nanoparticles as a catalyst to etch the armchair-shaped boundary orientation on *h*-BN surface. By introducing different metal nanoparticles under a similar standard etching process to control the key chirality problems of the groove etching, the chirality controllable planar heterostructure of graphene nanoribbons was successfully prepared. Research results are of great significance to the field of microelectronics. At the same time, they also used the stacking structure of AA' between the *h*-BN layers to successfully observe that protons can easily pass through *h*-BN layers, and explored its mechanism. Using this scientific phenomenon, it can be used for hydrocarbons and argon hydrogen. The hydrogen separation of mixed gas and other different gases provides a new way for the storage of new clean energy hydrogen sources. After these research results were published in high-level foreign journals, they attracted a lot of attention and became the ESI highly cited papers at the time. In addition, they also improved the quality of their patent applications. At present, they have successfully achieved the rational patent layout of *h*-BN nanostructures in the United States, Japan, Europe and China, authorized more than 20 invention patents in these regions, and has constructed a systematic patent protection network.

5. CONCLUSION

Improving the R&D quality in Chinese universities requires great efforts, including the construction of infrastructure such as laboratories and R&D equipment, the construction of high-quality research teams, and the ability to obtain the latest international patent and technical information. In order to strengthen the capacity building of patent information services, the State Intellectual Property Office and the Ministry of Education have established 60 National Intellectual Property Information Service Centers in universities across the country since 2019. The creation, use, protection, and management of intellectual property rights provide full-process services. We should actively improve the public service network of intellectual property information, provide valuable patent information for university researchers, serve the improvement of university innovation capabilities and the R&D quality, and serve universities sustained and stable development of R&D capabilities. As the main force of technological innovation in China, while improving their academic abilities, university researchers must also do high-quality R&D work through limited information resources and obtain more high-quality R&D achievement R&Ds.

AUTHORS' CONTRIBUTIONS

Yingchun Chen was responsible for writing, revising and editing the manuscript. Chi Zhang, Xian Zhang and Dunkui Chen contributed to discussing the idea of the manuscript.

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