Analysis of the Patent Information of SiC Ceramics Granted by China

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Abstract. Through analyzing the trend of patent number, the patent type and its classification, as well as the distribution of patentee types of SiC ceramics patents granted by China, a conclusion can be drawn that firstly, China's SiC ceramic industry is still under rapid development; secondly, the invention patent and the product patent take a dominant position; lastly, the main patent holders are Ningbo University etc.

1. Introduction
Because of its low density, low coefficient of thermal expansion, low hardness, high temperature resistance, high modulus of elasticity and corrosion resistance, SiC ceramics are widely used in ceramic ball bearings, semiconductor materials, measuring instruments, aerospace and some other fields [1-3]. At present, many countries begin to vigorously develop new SiC ceramics, but the production of SiC in China is still mainly based on upstream rough processing. To change this backward low-energy development mode, we must persist innovation in product development, actively cooperate with scientific research institutions and universities, and promote industrial upgrading. In Research Progress of SiC Ceramics, She Jihong find that the pressure-free sintering process of preparing high-density SiC ceramics shares a bright prospect [4]. Qin Chengjuan etc. think that it is urgent to improve their properties and reduce production costs [5]. Besides, Li Ying focuses on how to reduce the sintering temperature and to find a cheap production technology [6]. Omid Ebrahimpour etc. find a novel process which was developed to manufacture mullite-bonded porous SiC ceramics [7]. Feng Han and other researchers verify the effects of the amount of SiC whiskers on the porosity, bending strength, microstructure, and gas permeability of the SCPCs were investigated [8].

Nowadays, patent information has become the most important thesaurus of technology and relevant knowledge [9]. According to the WIPO, patent literature is one of the largest public sources of technical information, and the disclosure is 1-2 years earlier than other carriers [10]. The patent literature analysis can be efficiently used to predict the development trend, to discover the potential market and to provide suggestions for the enterprise to plan technology strategy [11]. Some scholars advise that a reasonable patent analysis system should be established, and they also argue patent analysis plays an important role in competitive intelligence work [12]. At present, the research on the patents of SiC ceramics is still a blankness. This paper, focusing on SiC ceramics, aiming to provide further study orientations for researching institutions through analyzing the trend of patent number, the distribution of the main patentees.
2. Data sources and collection
All data adopted in this paper come from the database provided by SIPO. Up to April 20, 2017, 652 granted patents on SiC ceramics had been obtained by screening statistics, and the information database of SiC ceramic patents granted by China had been established. In terms of research methods, the following independent variables are designed: patent type, patent classification, patentee type.

3. Analysis of patent information of SiC ceramics granted by China

3.1. Trend of patent number of SiC ceramics granted by China
The trend of annual number of patent can reflect the development trend in this field. Figure 1 shows the trend of the license number of SiC ceramics in China from 1986 to 2016, showing the development of the field over the 30 years.

![Figure 1. Trend of licensing number of SiC ceramics patents in China.](image)

As Figure 1 shows, the development of SiC ceramics can be divided into three stages. The first phase, from 1986 to 2001, saw little and even no growth in patent authorization, in which China has yet to start. The second phase, from 2002 to 2006, witnessed an increase in the number, while such increase is quite slow. During this period, SiC ceramic industry started in China. The third phase, from 2007 to 2016, the industry developed rapidly. Since 2009, the number of patents has grown dramatically, of reaching a peak of 88 in 2012. In 2015 and 2016, the number declined due to a quite long span of time of patent licensing. Thus, the data for two years don’t refer to a decline. The rapid increase reflects the trend of development, from which we can conclude the field of SiC ceramics in China is still in a period of rapid development.

3.2. Patent types and patent classification
There are three patent types: invention patent, utility model patent and design patent. Table 1 is the distribution of SiC ceramic patent types granted by China. It can be seen that there are totally 652 SiC ceramic patents, of which 402 are invention patents, 248 are utility model patents, and only 2 are design patents, which are negligible. The high proportion of invention patents indicates that the research on the preparation and modification of SiC ceramics occupies a large proportion.

The patent classification can be divided into three categories: product patent, method patent, product and method patent. Table 2 is the distribution of patent classification. There are 375 product patents, 188 method patents, 89 product and a method patents. It reflects the research focuses on the application of products. In combination with Table 1 and Table 2, we can see the theoretical research should be combined with practical application to promote the products improvement with the theory progress.

| Table 1. Distribution of patent types of SiC ceramics. |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Patent type                     | Invention patent| Utility model patent| Design patent | Total           |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Quantity (piece)                | 402             | 248             | 2               | 652             |
| Proportion                      | 62%             | 38%             | 0               | 100%            |
### Table 2. Distribution of patent classification of SiC ceramics.

| Patent classification          | Product patent | Method patent | Product and method patent | Total |
|-------------------------------|----------------|---------------|---------------------------|-------|
| Quantity (piece)              | 375            | 188           | 89                        | 652   |
| Proportion                    | 57%            | 29%           | 14%                       | 100%  |

### 4. Distribution of patentee types and authorization

The patentees are divided into five types: individual, university, research institution, enterprise and organization. Table 3 is the distribution of the patentee types. The number of patents granted by enterprises is the highest, and there are 211 cases in universities, taking the second place, and individuals ranked third, which is followed by scientific research institutes, and the organizations’ is the least which can be ignored. It shows the development of China’s SiC ceramics field is dominated by related enterprises and universities. In addition, individuals and research institutes have also made their own contribution. However, organizations have little help.

### Table 3. Distribution of patentee types of SiC ceramics.

| Patentee type       | Individual | University | Research institute | Enterprise | Organization | Total |
|---------------------|------------|------------|--------------------|------------|--------------|-------|
| Quantity (piece)    | 83         | 211        | 73                 | 283        | 2            | 652   |
| Proportion          | 13%        | 32%        | 11%                | 44%        | 0%           | 100%  |

![Figure 2](image-url)  

**Figure 2. Distribution of main patentee holders.**

Figure 2 lists the major patentees and the number of their related patents. The figure shows 17 patent holders own more than 5 patents (including 5). Among them, Ningbo University has the most patents, higher than other patentees. The second one and the third one are both research institutes. In combination with Table 3, the proportion of research institutes is the lowest. It can be inferred that this is due to the fact that their number is far less than that of enterprises and universities, instead its insufficient scientific research capacity. In Table 3, enterprises share the most patents, but in Figure 2, there are only two enterprises showing that corporate patents are too fragmented and lack of a complete patent system to protect intellectual property rights. Among 17 major patentees, the remaining 13 are universities. Combined with Table 3, Figure 2 shows that enterprises have insufficient research capacity and few patents, while universities have a lot of patents, large of which are not used in products. Therefore, enterprises should cooperate with universities and individuals, to improve not only their research ability, but the conversion rate of patent products.

### 5. Conclusions

Based on analysis of patent information of SiC Ceramics granted by China, the following conclusions can be drawn. First, in the light of patent types, invention patents account for 62%, and utility model patents account for 38%, while design patents are ignored. In terms of patent classification, the
proportion of product patents is the highest. We should further combine theory with practice, apply the methods to products and broaden the application fields. Second, for patentee types, enterprises account for the largest proportion; colleges also play an important role; individuals and research institutes participate in it actively; and organizations can be ignored. Through the analysis of the main patentees, only 17 patentees share more than five patents with two enterprises, two research institutes and the rest are universities. There are no enterprises that have obvious advantages in patent; on the contrary, the advantages of universities are more dramatic.

6. References

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