

Statistical Study of Patents Filed in Global Nano Photonic Technology

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Key words

nano photovoltaic technology (NPT); patent analysis; review; photoelectron device; semiconductor material; industry layout

Introduction

As one of leading core technology in the 21st century, nano photonic technology (NPT) is highly interdisciplinary, involving physics, chemistry, biology, materials science, and the full range of the engineering disciplines (Picraux, 2014). NPT is a study of the interaction of electrons and photons and its components in nano structure based on the great development and popularization of nanometre semiconductor materials (Liu, 2005). In 2011, NPT was identified as one of Key Enabling Technologies (KETs) for its vital role in strengthening Europe's industrial and innovation capacity (European Commission, 2011). It is widely used in telecommunications, optical interconnects, display, lighting, photovoltaic, sensors, data storage, imaging, and testing, etc (AIRI/Nanotec IT, 2008).

Patent analysis, which involves statistical, analytical, and comparative methods for examining information in patent documents, has been widely applied in studies examining R&D capacity, technological fields, industrial departments, and company levels (Pavit, 1988). Careful analysis of NPT-related patents can assist in elucidating technological details and relationships, identifying business trends, inspiring novel industrial solutions, and developing investment policies. Therefore, this study performed a statistical analysis of patent data to explore the technological developments of NPT. The technology life cycle and regional distribution of the patents were studied, and the top ten patent assignees were also explored.

Methodology

The searching for NPT patents from the Derwent World Patent Index (DII) database, keywords search were performed for the term appearing in titles, abstracts, or claims. The search strategy of DII database based on NPT was as follows: TS=(((solar or photovoltaic or "optoelectronic integrated device" or OEIC or "optic switch" or "holographic memory" or "light amplifier" or "optical amplifier" or ROADM or "optical add-drop multiplexer" or "optoelectronic display") and nano) or (optoelect* and (semiconductor or GaAs or

"gallium arsenide") and nano) or (("quantum well" or "quantum wire" or "quantum dot") and (laser or "photoelectric effect")) or "micronano laser" or "nano laser" or Nanophot* or "Nanowire laser" or "Uv nm laser" or "microcavity laser" or (nano same LED) or (nano same "light emitting diode")). After querying, filtering, and organizing the search results, 8168 NTP-related patents were obtained on December 12, 2014, and the data were analyzed using Thomson data analyzer (TDA).

Results and discussion

Figure 1 showed the evolution of the number of patents relative to the assignees, which is a typical value for exploring the technology life cycle base on patent data. It was showed that the number of patents and assignees increased gradually before 2000, indicating that the technology life cycle was in the introductory stage. This trend implied that few manufactures and institutions were investing in the R&D of NPT before 2000. By contrast, the number of patents and assignees increased rapidly after 2000, particularly during the 2007-2013 periods, indicating that the technology had entered the growth stage. Specifically, the number of patents (assignees) increased from 378 (558) in 2007 to 1006 (843) in 2013.

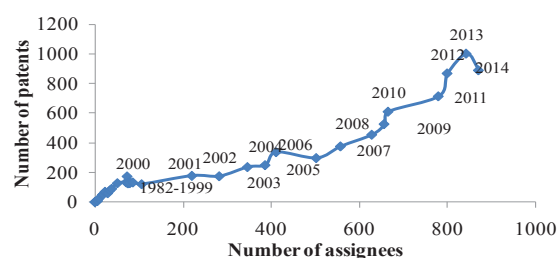


Figure 1. Technology life cycle

Figure 2 showed the number of patents filed in various countries/offices, as well as the trend of the number of patent applications. China (CN), Japan (JP), United State (US), WIPO (WO), and Korea (KR) were the top five countries/offices, with the number of patent applications of 2133, 1964, 1946, 970 and 656. The number of patent applications filed in CN was the highest, indicating that the NPT market in CN might offer the most potential for future development. Compared with other countries, the filing of NPT-related patents commenced only recently in CN, although the number of patent applications increased markedly in 2004-2014.

Moreover, the NPT-related patents were filed earliest in US and WO, and the number of patent applications of these two countries grew rapidly since the beginning of 2004.

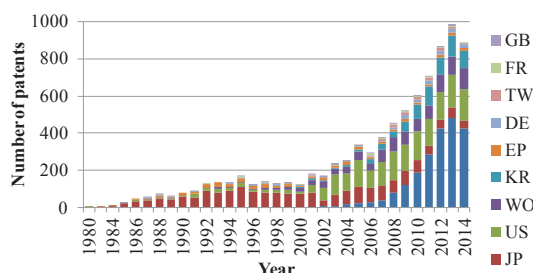


Figure 2. Number of patents and its evolution by country/office. The initialisms “WO” and “EP” indicate that the patent was filed in the WIPO and EPO, respectively.

Table 1 showed a summary of the top ten patent assignees. It was found that all of top ten patent assignees were from JP except *Semiconductors Institute of Chinese Academy of Sciences* and *Samsung Electronics Company, Limited*. In addition, the JP assignees were all companies, and these JP companies had already manufactured commercial NPT products. Furthermore, the JP and KR assignees were filed their patents in many countries/offices for the global layout of NPT. By contrast, *Semiconductors Institute of Chinese Academy of Sciences* filed patents only in CN.

Table 1. Top 10 patent assignees.

Assignee (nationality)	No. of patents	No. of application countries	Times cited (average)
NEC Corporation (JP)	280	4	425 (1.5)
Mitsubishi Denki K.K. (JP)	188	7	402 (2.1)
Fujitsu Limited (JP)	179	5	210 (1.2)
Sharp KK (JP)	170	6	430 (2.5)
Hitachi Limited (JP)	156	4	187 (1.2)
Samsung Electronics Company, Limited (KR)	153	6	137 (0.9)
Semiconductors Institute of Chinese Academy of Sciences (CN)	143	1	71 (0.5)
Furukawa Electric Company, Limited (JP)	138	6	423 (3.1)
Nippon Telegraph & Telephone Corporation (JP)	132	3	30 (0.2)
Matsushita Denki	115	5	286

Sangyo KK (JP)			(2.5)
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Conclusion

This study analyzed patent data to explore the technological developments of NPT. After querying, filtering, and organizing the search results, this study analyzed 8168 NPT-related patents. The primary findings of this study were detailed as follows.

(1) Based on the analysis results, the technology life-cycle status of the NPT is currently in the growth stage, indicating that many products were sufficiently developed for commercialization.

(2) US assignees were the most prominent assignees, although the most patent applications were filed in CN, indicating that the market for NPT in CN might offer the most potential for future development.

(3) All of the top ten assignees were from JP, KR, or CN. The JP and KR assignees were all companies, and the assignees were filed their patents in many countries/offices for the global layout of NPT and products. By contrast, *Semiconductors Institute of Chinese Academy of Sciences* is academic institution and filed patents only in CN.

Future studies should consider evaluating the current state of NPT developments in a specific field to identify application areas for new patents.

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