Field: Industrial Production and Production Technology

Achievement: Contributions to high-density magnetic recording technology by the development of a perpendicular magnetic recording method

Prof. Shun-ichi Iwasaki

Born: August 3, 1926
Director, Tohoku Institute of Technology
Professor Emeritus, Tohoku University

Summary

LSI (large-scale integration) and the HDD (hard disk drive) which records information have played major roles in the progress of computer technology in the 20th century. It is not an exaggeration to say that the miniaturization and the increasing capacity of the HDD have created the information society through the Internet. Furthermore, what is giving behind-the-scenes support to the attainment of the next-generation system such as cloud computing is the ever-increasing capacity of the HDD by means of the perpendicular magnetic recording method. Prof. Shun-ichi Iwasaki, through inspiration from the research of the magnetic recording principle, has developed the perpendicular magnetic recording method, which is more advantageous in attaining higher capacity in comparison to the conventional horizontal magnetic recording method. Since he advocated this method to the world in 1977, he has continued research and development for the practical application thereof.

Higher capacity hard disk as the goal

The HDD was developed as a magnetic recording device for the U.S. computer "IBM 305 RAMAC" in 1956. Its structure was 50 magnetic disks of a 60 cm diameter stacked one on top of the other, and the overall size of the device was equivalent to 2 large refrigerators. Despite its size, the data capacity was about 4.8MB. Thereafter, with the progress in computer technology, miniaturization and higher capacity HDD was attained, and in the 1990's, even personal computers (PC) came to be equipped with HDDs of approximately 20MB. In the latter half of the 1990's, music, graphics and videos came to be saved onto files, prompting an even further increase in capacity. Presently, HDDs of approximately 500GB are used for home PCs, which is 100,000 times that of the "IBM 305 RAMAC."

As mentioned above, HDD has been progressing with higher capacity as the goal, but from around the year 2000, theoretical limitations to this progress were pointed out. With regard to magnetic recording, the horizontal magnetic recording method was used from the advent of tape recorders. However, with this method, further capacity increase was difficult. Then, a generational change from the horizontal magnetic recording method to the perpendicular magnetic recording method took place. Prof. Iwasaki developed the perpendicular magnetic recording method more than 30 years ago, and has continued a steady and persistent research ever since. When it was found that the horizontal magnetic recording method could not keep up with the developments in the information society, the potential of the perpendicular magnetic recording method came to be recognized.

Shedding light on the basic research of magnetic recording

After graduating from the School of Engineering at Tohoku University in 1949, Prof. Iwasaki joined Tokyo Tsushin Kogyo (now Sony Corporation). However, at the recommendation of his professor and mentor Prof. Kenzo Nagai, who is known for the development of the magnetic recording method (AC biasing method) which is used in tape recorders, he decided to go back to the university in 1951 to further pursue his studies in magnetic recording. Prof. Iwasaki worked in analysis of alloys which are used as magnetic material for magnetic tapes in audio recording. As a result of his research, miniaturization and improved sound quality of tape recorders were achieved. However, Prof. Iwasaki's interests extended to the clarification of the magnetic recording principle itself.

Tapes and disks which are used for magnetic recording have a magnetic layer on the media surface. Small magnets are considered to be aligned on the surface, and by means of an external magnetic force, the direction can be changed to record signals. With conventional technology, the direction of these magnets is parallel to the tape and disk surface, thus called the horizontal magnetic recording method. Prof. Iwasaki accurately verified the state of the magnetic material recorded under the horizontal magnetic recording method. As a result, he discovered that a magnetic layer exists not only in the horizontal direction but also in the perpendicular direction as well, and depending on the balance, the magnetic recording can be done in a horizontal direction. At that point, Prof. Iwasaki's thought was, "if the balance were to be changed, the magnetic recording can be done in a perpendicular direction."

At that time, it was thought that if the magnets could be aligned in a perpendicular direction, theoretically, the signal recording density would be dramatically increased. In addition, if the magnetic layer were to be magnetized to record the signals, the south and north poles on the signal magnet would be magnetized one next to the other, thus increasing the recording density in a steady manner. However, little progress was seen in the technical research into the practical application of these findings. In order to verify his ideas, Prof. Iwasaki repeatedly made prototypes of magnetic heads and magnetic layers, and at last he became confident to the point that he could say, "the perpendicular magnetic recording will bring about a revolution in magnetic recording." He received an enthusiastic response when the results of his studies were presented at the international conference in Los Angeles in 1977.

Paving the way for the next-generation information society

Coming into the 80's, universities around the world formed research centers for the study of the perpendicular magnetic recording method. Japanese electronics manufacturers also embarked on the research and development thereof, but implementation seemed still far into the future. Unlike the horizontal magnetic recording method with an approximately 100-year history, with the perpendicular magnetic recording method, it was necessary to start research on the magnetic heads and recording media from scratch. In addition, there were technical innovations with the horizontal magnetic recording method as well, and higher capacity storage devices were being achieved. There were very few researchers willing to venture into the field of the perpendicular magnetic recording method.

In such an environment, Prof. Iwasaki who continued to pioneer the perpendicular magnetic recording method with Tohoku University as his base, had a conviction. He called it, a "20-year rule," adding that "in order for a technology to pave the way to a new generation in the true sense of the word, it would take more than 20 years for it to be established." In this way, he spurred young researchers on to continue the research. Additionally, he continued to advocate to the world the superiority of the perpendicular magnetic recording method by revealing its technology.

It was not until after the year 2000 that the "times" finally caught up with this innovative technology. The Internet has become widespread to the point that anyone can access the enormous amount of information around the world, and not only characters and images but also videos have come to be used tremendously. Further increase in capacity was sought after, and once again the limitations of the horizontal magnetic recording method were evident. With the horizontal magnetic recording method, the magnets are aligned in the magnetic field direction, thus affecting the nearby magnetic force. Therefore, it is not possible to reduce the size of the magnets beyond a certain level.

Meanwhile, as research into the perpendicular magnetic recording method had been conducted in persistent and steady manner, researchers were able to commercialize their technology at this turning point. In 2005, a Japanese electronic manufacturer was the first in the world to develop an HDD using the perpendicular magnetic recording method. In 2006, major global HDD manufactures began production of HDD using the perpendicular magnetic recording method, and in 2007 the production of such reached 500 million worldwide, resulting in a significant generational change in HDD. In the year 2010, it is estimated that all HDDs produced worldwide will be switched to the perpendicular magnetic recording method.

At present, "total digitalization" where all intellectual properties around the world are shared via the Internet, is being proposed. The perpendicular magnetic recording method founded by Prof. Iwasaki shall continue to make contributions to society as the basic technology which will achieve the dream of the new information society.

Horizontal magnetic recording method and perpendicular magnetic recording method