MAKING A BIG LEAP IN MAGNET INNOVATION

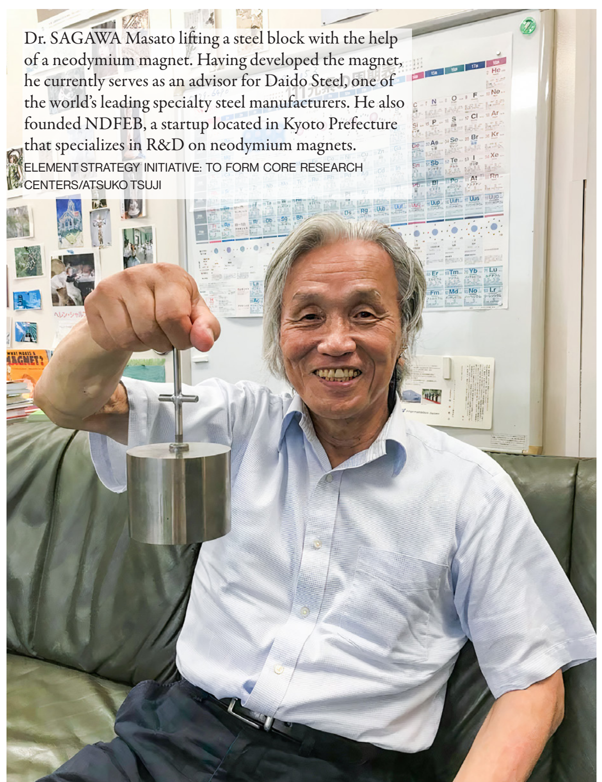
The neodymium magnet has enhanced the performance of a wide range of products, from electronic devices to electric vehicles and wind turbines. The magnet's inventor and developer, who was recently awarded the world-renowned Queen Elizabeth Prize for Engineering, speaks about the driving forces that led to this breakthrough and the potential for upcoming technological innovations.

The shift to electric vehicles and fuel cell vehicles is accelerating around the world, as many countries strive to achieve carbon neutrality. Japan is also promoting the widespread use of these vehicles and has set the goal of having electrified vehicles account for 100% of new passenger car sales by 2035.

Among the various technological innovations that have enabled the mass production of electric vehicles, the most crucial has been the neodymium magnet (also known as the NdFeB magnet). Featuring high heat resistance and powerful magnetic strength—strong enough that one gram of it can lift 1kg of steel—the magnet has made possible the creation of the small and powerful motors that are indispensable for such vehicles. It has also contributed to enhanced performance and reduced costs in a broad range of items, from HDDs used for personal computers to air conditioners and wind turbines.

"I didn't think it would be used so widely," says SAGAWA Masato, the Japanese scientist who developed the magnet in 1982. In February 2022, he was awarded the Queen Elizabeth Prize for Engineering—one of engineering's most prestigious awards, honoring bold, groundbreaking innovations that are of global benefit to humanity—for developing the world's most powerful permanent magnet, which has been transformational for its contribution towards enabling cleaner, energy-saving technologies. "To have something I devised myself be of such benefit to society—I couldn't be happier," he adds.

Back in the day when the strongest magnets were deemed to be those made mainly from the two basic elements of samarium and cobalt, Sagawa turned his attention to iron. Pursuing a hunch that excellent magnets could be made from iron—less expensive and more plentiful than cobalt—Sagawa began conducting his own research in that direction while working on developments such as samarium-cobalt magnets at a major Japanese electronics manufacturer. He didn't receive the go-ahead from his company to develop an iron-based magnet, however, since the element was considered unsuitable for making a super-strong magnet. But believing that such a magnet would surely contribute to the world, he continued to persist with his work, and in 1982, after joining Sumitomo Special Metals (now Hitachi Metals), he succeeded in developing the neodymium magnet.



Dr. SAGAWA Masato lifting a steel block with the help of a neodymium magnet. Having developed the magnet, he currently serves as an advisor for Daido Steel, one of the world's leading specialty steel manufacturers. He also founded NDFEB, a startup located in Kyoto Prefecture that specializes in R&D on neodymium magnets. ELEMENT STRATEGY INITIATIVE: TO FORM CORE RESEARCH CENTERS/ATSUKO TSUJI

Neodymium magnets (center) are mainly composed of iron—an abundantly available and inexpensive substance—along with neodymium and boron. Their low cost has led to their rapid popularization and has greatly improved performance for a wide range of products: from air conditioners to personal computers, electric vehicles, and wind turbines. AFLO (top left photo); SHUTTERSTOCK (center, top right, and bottom left); EYEEM (bottom right)

Spurred on by the advantages of its low cost and having twice the magnetic force of the samarium-cobalt magnet, applications of the neodymium magnet spread rapidly. Even now, nearly four decades later, there is no magnet that can surpass it.

Now aged 78, Sagawa can still be found at the frontline of development working to improve the neodymium magnet. He recently succeeded in substantially reducing the magnet's ratio of dysprosium—a heavy rare-earth element in particularly scarce supply—while enhancing its strength. This magnet also has the potential to improve energy efficiency through properties that help keep the temperature of the motor from rising. "Motors consume almost half of the world's electricity. The widespread use of electric vehicles will only result in further consumption. Under such circumstances, even the slightest improvement in motor efficiency will contribute substantially to carbon neutrality," he says.

Japan has developed technological innovations not only in magnets, but also in such materials as carbon fiber and high-tensile steel, which play crucial roles in creating products in a broad range of fields. According to data for 2017, Japanese companies accounted for at least 60% of the global market for up to 70 advanced materials used in high-tech fields. "Materials have been the backbone supporting civilizations from time immemorial. We can solve extremely large problems through the innovation of materials. That's why I want young researchers to find projects that will benefit society and aggressively pursue them," states Sagawa. With the aim of making the world more convenient and eco-friendly, Japan will continue along this path to seek new innovations. ●

A major feature of the neodymium magnet (left) is its strong magnetic force; it is about 10 times stronger than a ferrite magnet (right), the most widely used magnet in the world, including for daily necessities. NATIONAL INSTITUTE FOR MATERIALS SCIENCE