

Dr. Sagawa's Research: Invention of the Neodymium Magnet and Sintering Process

In 1975, Dr. Masato Sagawa was working on research to reinforce the mechanical strength of the samarium-cobalt magnet. In this research, he was questioning why magnets made from iron, which is abundantly available and has a high magnetic moment, does not exhibit a high coercivity. Meanwhile, he learned that the development of rare earth and iron (R-Fe) magnets had been difficult due to the small interatomic distances between the iron atoms. With this knowledge, he developed a hypothesis that adding elements with a small atomic radius between the iron atoms would expand the iron's interatomic distance. He then started making alloys of various compositions by putting different minerals into an arc furnace. He chose elements with small atomic diameters, such as carbon and boron, as additives to the R-Fe alloy, and tested various rare earth elements, including samarium and neodymium. In 1978, he eventually found that the combination of neodymium, iron, and boron produced the greatest coercivity.

Dr. Sagawa's detailed study then extended from various compositions to different manufacturing conditions, including different particle sizes of alloy powder and thermal applications. As a result, he established his own sintering process, in which the magnetic powder is compressed in a mold for shaping and then sintered to form bonds between the particles to reinforce the mechanical strength.

Sintered neodymium magnets showed a maximum energy product(*) of 320 kJ/m^3 (the maximum energy of the samarium-cobalt magnet at that time was 240 kJ/m^3). Mass production of the magnet began only three years from the time that Dr. Sagawa applied for the patent in August 1982. This permanent magnet was originally used in automobiles and home appliances, but today it is used extensively throughout the world, for example, in EV motors and wind turbines.

Note:

* Maximum energy product: The maximum value of the energy obtained from a magnetic material.

Dr. Masato Sagawa

Adviser, Daido Steel Co., Ltd.

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Born

August 3, 1943, Tokushima, Japan

Education

1966 B. A., Department of Electrical Engineering, Kobe University

1968 M. A., Department of Electrical Engineering, Kobe University

1972 Dr. Eng., Metallurgical Materials Engineering, Graduate School of Engineering, Tohoku University

Employment History

1972-1982 Fujitsu Ltd.

1982-1988 Sumitomo Metal Industries, Ltd. (now Proterial, Ltd.)

1988-2012 Established Intermetallics Co., Ltd., Appointed as Representative Director

2013-present Established NDFEB Corporation, Appointed as Representative Director

2016-present Adviser, Daido Steel Co., Ltd.

2017-2019 Adviser, Nippon Densan Co., Ltd. (now NIDEC Corporation)

2017-2019 Specially Appointed Professor, Institute of Advanced Energy, Kyoto University

2019-present Distinguished Invited University Professor, Tohoku University

2019-present Guest Professor at the China Iron and Steel Research Institute

2019-present Guest Professor, Central Iron & Steel Research Institute, China

2022-present Senior Fellow, Research Promotion Organization for Carbon Neutrality, Meijo University

Awards

1984 Osaka Science Prize

1985 Minister of Science and Technology Agency Award

**1986 International Prize for New Materials, American Physical Society
(now James C. McGroddy Prize for New Materials)**

1988 The Japan Institute of Metals and Materials Meritorious Award

1990 Asahi Prize

1991 Japan Magnetics Society Award

1993 Okochi Memorial Prize

1998 Acta Metallurgica J. Hollomon Award

2003 Honda-Kinen Prize

2006 Kato-Kinen Prize

2012 Japan Prize

2016 Special Award, Nagamori Award

2018 NIMS Award 2018

2020 The Japan Institute of Metals and Materials Gold Medal Award

2022 Queen Elizabeth Prize for Engineering

2022 IEEE Medal for Environmental and Safety Technologies

Publications

- “Permanent Magnets: Materials Science and Applications”, Masato Sagawa, Masaaki Hamano, Makoto Hirabayashi, AGNE Gijutsu Center Inc., ISBN 978-4-901496-38-4 (2007)
- “All About Neodymium Magnets: Protecting the Earth with Rare Earths”, Masato Sagawa, AGNE Gijutsu Center Inc., ISBN 978-4-901496-58-2 (2011)
- “The Work Style of the Strongest Engineer”, Shuji Nakamura, Masato Sagawa, Jitsumukyoiku-Shuppan Co., Ltd. ISBN 978-4-788911-95-6 (2016)