NAITO Yoshiyuki　"Development of Thin Microwave Absorbers and Electromagnetic Wave Circuits"

1. Biography

(NAITO Yoshiyuki)

NAITO Yoshiyuki was born on November 22, 1936. He graduated from Tokyo Institute of Technology (Tokyo Tech) in 1959 and was awarded Ph. D. Engineering, Tokyo Tech in 1964. He became a research associate, Tokyo Tech in 1964, an associate professor, Tokyo Tech in 1967 and a professor in 1980, respectively. He was named Director of Tokyo Tech International Cooperation Center for Science and Technology in 1986, Dean of Students, Tokyo Tech in 1992 and Dean of Faculty of Engineering, Tokyo Tech in 1993, respectively. He became Professor Emeritus, Tokyo Tech in March 1997, President of National Institute of Technology, Tokyo College in April 1997, President of Tokyo Tech in October 1997, President of Oita University in 2002, and President of National Institute of Technology in 2004, respectively. He was awarded IEEE Fellow in 1988, Inada Award by Institute of Electrical Communication Engineers of Japan in 1961, Best Paper Award by the Institute of Electronics and Communication Engineers of Japan in 1967, Best Paper Award and Achievement Award both in 1994, and Distinguished Achievement and Contributions Award in 2000, all by the Institute of Electronics, Information and Communication Engineers. Also, he was awarded the Tokyo Science and Technology Achievement Award in 1996. He passed away on June 15, 2011 (74 years old).

2. Abstract

NAITO Yoshiyuki has been involved in research and education of microwave absorbers and electromagnetic wave circuits in the microwave, millimeter wave and light wave frequency bands. In particular, his research achievements on thin ferrite-based microwave absorbers that absorb electromagnetic waves in a wide frequency range are highly regarded both in Japan and abroad. His contributions to the practical application of microwave absorbers has been greatly recognized through installation of absorbers on the exterior walls of buildings as well as anechoic chambers. He also promoted research on the use of magnetized ferrites to realize isolators and circulators with unidirectional propagation characteristics in planar electromagnetic wave circuits. In addition to those research activities, he served as Dean of Students, Dean of Faculty of Engineering, and President of Tokyo Institute of Technology, contributing greatly to the management of the Institute.

3. Research Achievement

3.1 Development of thin microwave absorbers

In order to eliminate interference with electronic equipment caused by electromagnetic waves, it is essential to reduce the power of unwanted electromagnetic waves radiated from equipment and to realize immunity of equipment to unwanted electromagnetic radiation. Electromagnetic wave anechoic chambers play an important role in the measurement of electromagnetic radiation from electronic equipment and the immunity of equipment to electromagnetic interference. The chamber is built by shielding the chamber with a conductor. In addition, a microwave absorber is installed inside the chamber to prevent the reflection of unwanted electromagnetic waves inside the chamber. Conventional microwave absorbers are composed of lossy dielectrics containing carbon powders. The absorber had the disadvantage that the thickness was as thick as about 60 cm for obtaining sufficient microwave absorption characteristics.

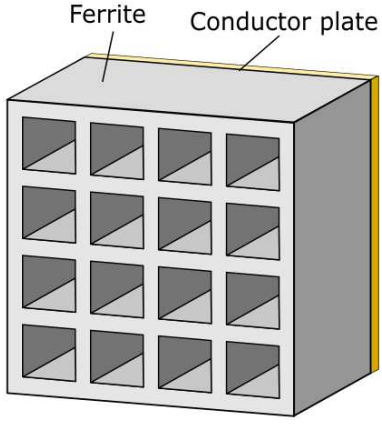

Fig. 1 Grid microwave absorber

In order to reduce the absorber thickness and to secure as much space as possible inside an anechoic chamber, NAITO Yoshiyuki developed a novel grid type microwave absorber employing magnetic loss of ferrite (Fig. 1) [1]. The absorber could suppress the reflection in a frequency range of 30 MHz to 700 MHz to less than 1/100 with a thickness of 2 cm. The absorber provided an EMC measurement environment with the characteristics specified by the Federal Communication Commission. Furthermore, by combining ferrite and dielectric lossy material, he succeeded in achieving the characteristics of suppressing the microwave reflection from 30 MHz to 1800 MHz to 1/100 or less [2].

3.2 Electromagnetic-wave circuits

NAITO Yoshiyuki promoted research on passive electromagnetic wave circuits in the microwave, millimeter wave, and light wave frequency regions. In particular, he worked actively on the realization of nonreciprocal circuits such as isolators and circulators in planar circuits employing the magnetic material ferrite. In the microwave and millimeter-wave frequency bands, he focused on a new propagation mode called edge guided mode propagated in a microstrip line formed on a magnetized ferrite substrate. This propagation mode had a different electromagnetic field distribution depending on the propagation direction. This was used to realize isolators that propagated electromagnetic waves in only one direction, and circulators in which the input and output ports of electromagnetic waves were arranged in a circular manner.

Furthermore, in the light wave frequency band, an optical waveguide composed of a magnetized single-crystalline magneto-optic material $Y_3Fe_5O_{12}$ thin film was formed to experimentally demonstrate the nonreciprocal phase shift, in which light waves propagated at slightly different speeds depending on the propagation direction [3]. He promoted research on waveguide optical isolators utilizing this effect. This work led to the realization of waveguide optical isolators and circulators about 25 years after the experimental verification of the nonreciprocal phase shift [4].

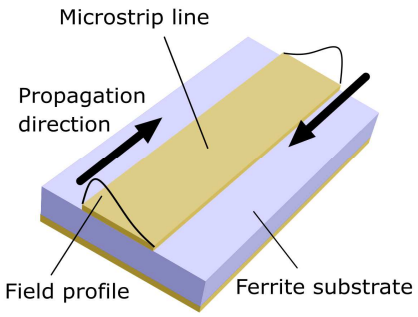

Fig.2 Edge guided mode

4. References

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[3] T. Mizumoto and Y. Naito, “Nonreciprocal propagation characteristics of YIG thin film,” IEEE Trans. on Microwave Theory and Techniques, vol. MTT-30, pp. 922-925 (1982). DOI: 10.1109/TMTT.1982.1131173/
[4] Y. Shoji, T. Mizumoto, H. Yokoi, I-Wei Hsieh, and Richard M. Osgood, Jr., “Magneto-optical isolator with silicon waveguides fabricated by direct bonding,” Applied Physics Letters, vol. 92, 071117 (2008). DOI: 10.1063/1.2884855

5. Representative Books (all in Japanese)

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[2] Basic Electric Circuit (Kiso Denki Kairo) (Shokodo, 1976)
[3] Electrical Mathematics I / II (Denki Sugaku I / II) (Morikita Publishing, 1976)
[4] Basic Mathematics for Electricity and Electronics (Denki Denshi Kiso Sugaku) (IEEJ, 1980)
[5] Microwave and Millimeter Wave Engineering (Microha Miriha Kogaku) (Corona Publishing, 1986)
[6] Microwave Absorber (Denpa Kyushutai) (Ohmsha, 1987)

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