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Pioneering Study on Terahertz Wave Radio

In information and telecommunications networks, the transmission speed gap between cable communication (Optical fiber, etc.) and wireless communication exceed more than one digit, and previously this was a big problem.

T. Nagatsuma, A. Hirata, T. Kosugi, et al., challenged this, using electromagnetic waves of frequency bands exceeding 100GHz as a breakthrough for the development of broadband wireless communication. They realized a wireless communication system with a transmission speed of 10Gbit/s (uncompressed high-definition picture signal was transmitted with 6 channels at max) by challenging the use of electromagnetic waves in the frequency band over 100 GHz and using 120 GHz charged waves, they became the forerunner in research and development on terahertz wave radio.

In particular, the technology to generate/detect millimeter waves/terahertz magnetic wave of 100GHz－1THz with photonics technology developed in the 1990s and became the basis of pioneering a new magnetic wave band.

Radio systems using band radio waves of 120GHz first used photonics technology, but this was later realized by electronics with InP HEMT, and was used for the relay broadcasting of the Beijing Olympics in 2008.

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Development and Realization of Ultraminiature Wireless IC Tag

In recent years, progresses in semiconductor manufacturing technologies have been significant, and the downsizing and development of high functionality are on-going. Among others, development technologies for compact devices were tried to apply to the communications and information equipment fields, and they are expected to serve as ubiquitous infrastructure technology in society.

From the latter half of the 1990s, Mitsuo Usami worked on the development of ultraminiature wireless IC tag chips (mu chip) and succeeded in developing wireless IC tag technology for the world's smallest chip size (0.4 mm square). At EXPO 2005 AICHI, this chip was mounted to an admission card, contributing to the technological innovation of wireless IC tags and the development of its application.

Mechanical strength, low price, and high reliability were required for wireless IC tags. M. Usami discovered the fact that mechanically fragile IC chips were able to bring about remarkable improvements in strength with the size of square of 0.5 mm or less. Because of

this, he did not depend solely on miniaturization of the process but he realized the following ideas which allowed to downsizing the chip in a fundamental way, eventually realizing ultraminiature wireless IC tag chips.

1. Substituting wiring-type ROM for conventional writable ROM function to store the ID number and merchandise information.
2. Downsizing ROM capacity down to 128-bit, the same size as IPv6.
3. Employing a simple communication protocol which eliminated the use of command control and cutting down the logic circuit size and reducing smooth capacity down to 80pF.
4. Inventing a double-sided electrode nappe structure which enables the construction of an antenna group and chip group with patch connection so as to resolve the mounting problem due to chip microminiaturization and to reduce the price as well.
5. Developing glass sealing technology excellent in dependability based on this chip structure and expanding its application areas, e.g., mounting on vehicles.
6. Succeeded in developing technology to mount the world's smallest antenna of 0.4 mm square on bank bills for forgery prevention.

After the release of this product, the technology evoked a massive response. Among others, employment in the entrance ticket system at the EXPO 2005 AICHI, the steel stock automatic identification control system, and the production record system of agricultural produce were decided. Taking this opportunity, the full-swing realization of ultraminiature wireless IC tags became active. In 2005, he received the IEICE achievement award.