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1987

Release of a low-noise HEMT for satellite TV reception (Fujitsu and Sony)

~ Discrete Semiconductor/Others ~

The possibility of microwave and millimeter wave low noise amplification by HEMT had been proven in several research institutes both in Japan and abroad since around 1984. HEMT crystals had been made by MBE (Molecular Beam Epitaxy), and the molecular beam epitaxy equipment GEN II by Varian had been legendary. Although the MBE crystal growth method was excellent as an experimental apparatus, it was not suitable for large-diameter crystal growth and mass production, and a crystal growth method suitable for mass production had been required.

Tanaka et al. of Sony developed a technology to grow AlGaAs / GaAs hetero-junction crystals with a two-dimensional electron gas layer with high electron mobility by MOCVD method using trimethyl metal compounds (TMA, TMG) and arsine (AsH_3). As shown in the Figure, the new techniques were implemented such as introducing an undoped AlGaAs spacer layer with a thickness of 10nm to the AlGaAs/GaAs hetero interface or introducing an AlAs / GaAs superlattice buffer layer to stop the propagation of crystal defects from the substrate crystal.

Using this crystal, HEMT with noise figure of 0.8dB and gain of 12.5dB at frequency of 12GHz was developed and commercialized.

In addition, Joshin and Hanyu et al. of Fujitsu devised a T-shaped self-aligned type HEMT and realized the performance with a noise figure of 0.54dB and a gain of 12.1dB at a frequency of 12 GHz, and commercialized it.

NHK-BS1 started 24-hour broadcasting in 1987, and the European Telecommunications Satellite Organization (Eutelsat) also launched a satellite covering Eastern Europe in 1989, and the satellite TV era started. Since TV broadcasting could be received with an indoor parabola antenna with a diameter of 30cm or less by using the low noise HEMT, it was used extensively.

In the 1990s, domestic companies (Toshiba, NEC, Mitsubishi Electric) also entered this field and these devices are still actively used as important devices in the microwave and millimeter wave bands.

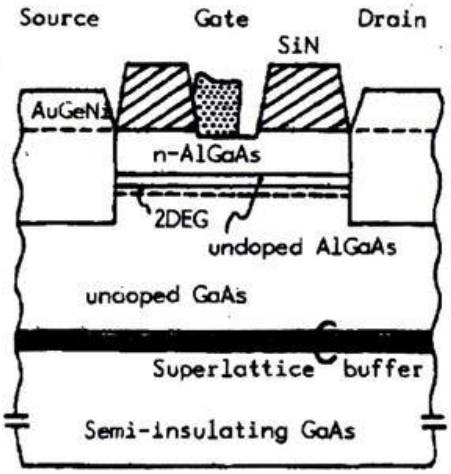

Fig. 1. Cross section of low-noise HEMT.

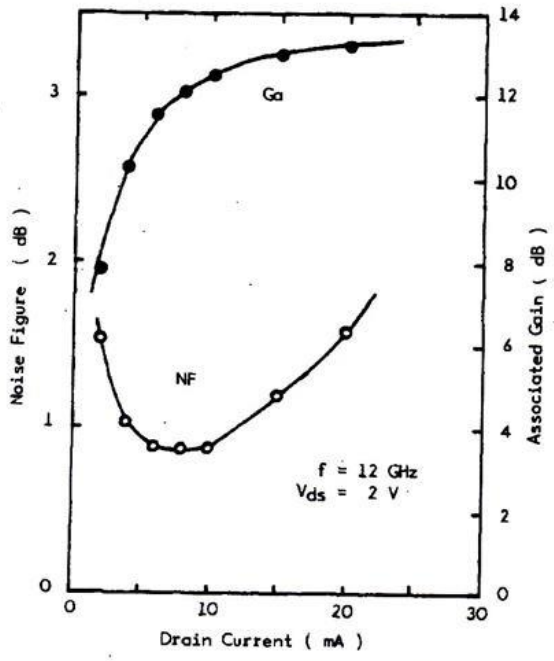

Fig. 6. Noise figure and associated gain as a function of drain current.

A noise figure of 1dB or less was achieved at 12GHz(1)

References:

(1) K. Tanaka, et.al, “Low-noise HEMT using MOCVD” IEEE Trans. Electron Devices, vol ED-33, No. 12, pp. 2053-2058, (Dec. 1986)
(2) S. Fujita et. al., “Extremely low noise InGaAs/InAlAs HEMT grown by MOCVD” Electronics Letter Vol.29, no.17, pp. 1557-1558 (Aug. 1993)
(3) K.Joshin et al., “Low noise HEMT with self-aligned structure” Conf. on Solid State Devices & Materials, pp347-350, (1984)
(4) I. Hanyu et al., “Super low-noise HEMTs with a T-shaped WSi gate” Electron Letter, Vol. 24, pp1327-1328 (1988)

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