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1974

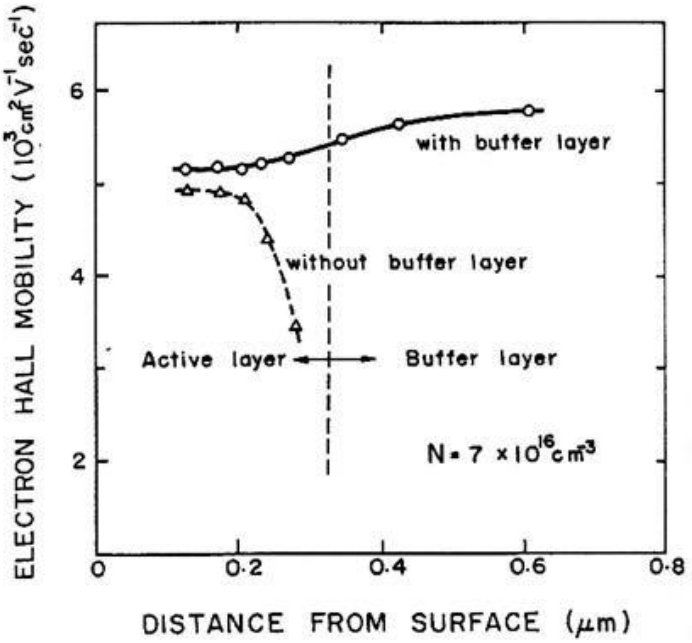
Release of a commercial low-noise gallium-arsenide MESFET (NEC)

~ Discrete Semiconductor/Others ~

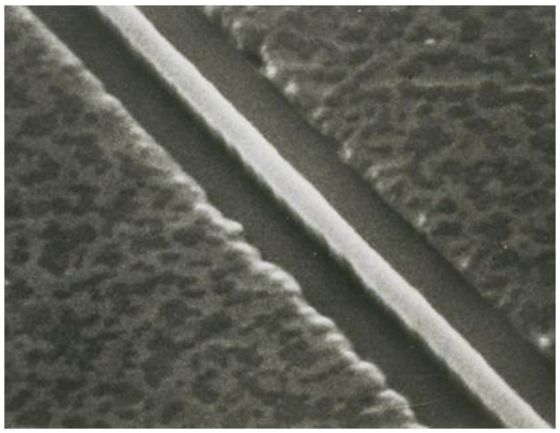
NEC quickly paid attention to the promising potential of GaAs MESFET (Metal Semiconductor Field Effect Transistor) as a microwave transistor, and it started research and development since 1970. In order to obtain good microwave characteristics, especially low noise characteristics, improvement of cutoff frequency and transconductance gm and reduction of parasitic resistance were the key.

For this reason, in the crystal growth technique, a high-purity buffer layer was introduced at the interface between the n-type channel layer and the semi-insulating substrate to prevent a decrease in electron mobility at the interface of the substrate, and a high gm was realized. In the electrode formation technology, a fine self-alignment device process was developed using a conventional photolithography, in which a short gate electrode was formed by side etching of Al having low resistance and stable Schottky property. Formation of a source/drain ohmic electrodes was done by vacuum evaporation deposition of Au-Ge utilizing the same photoresist mask used for gate electrodes etching as a lift-off mask. They achieved high cutoff frequency and low gate-source channel resistance. In addition, they clarified the alloy reaction mechanism of Au-Ge electrode with GaAs and developed a technology of low resistance and highly reliable ohmic electrode.

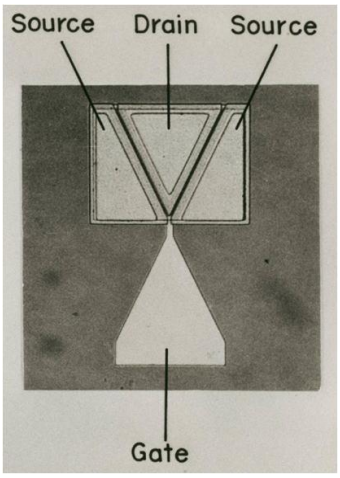
By applying these techniques, NEC developed high performance and highly reliable 1μm gate low noise GaAs MESFET (NE 244) with a noise figure of 1.4dB (gain of 13.5dB) and maximum gain of 17dB at 4GHz. It was the world first 3-terminal solid state (semiconductor) device which could be used in C~X band (4~12GHz). Commercialization of this GaAs MESFET, and subsequent development and commercialization of 0.5μm gate ultra-low noise MESFET (NE 388, NE 137), etc., greatly contributed to miniaturization, high performance and wide use of ground microwave communication relays, satellite communication ground stations, and microwave radio communication equipment



Electron mobility profile of vapor phase epitaxial layer [4]



SEM image of source-gate-drain electrode [4]



1μm gate low noise GaAs MESFET chip [4]
(Gate width: 150μm × 2 = 300μm)

References:

(1) T, Nozaki et al., Proc. 1974 Int'l Symp. GaAs and Related Compound, pp. 46-54.
(2) US Patent, 3,994,758.
(3) K. Ohata and M. Ogawa, Proc. 12th Ann. Reliability Phys. Symp. (1974), pp. 278-283.
(4) M. Ogawa et al., IEEE Trans. Microwave Theory Tech., MTT-24, pp. 300-305 (1976).
(5) T. Irie et al., ibid, pp.321-328 (1976).

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