

# 1985

## Invention of the U-MOSFET (Matsushita Electric Works)

~ Discrete Semiconductor/Others ~

MOSFET has characteristics of high input impedance and thermal runaway hardly occurs, and it was expected as a high-power and high-speed switching element. However, it has a major problem that the ON-resistance is higher than that of bipolar devices.

In the power MOSFET, vertical structures were adopted in order to increase the gate width per unit area, and at that time, VMOSFET and DMOSFET (Double Diffusion MOSFET) were developed. Ueda et al of Matsushita Electric devised U-MOSFET by using reactive ion beam etching (RIBE) to form U-grooves in a silicon substrate and made the side surfaces of the grooves into MOSFET channels, as shown in Fig.1. ON-resistance was analyzed with a current path model as shown in Fig.2 and 3, and it was shown that the new structure was excellent as shown in Fig.4.

Ueda named this MOSFET as RMOSFET (Rectangular-grooved MOSFET), but names of UMOSFET or trench gate type MOSFET were established in the industry. UMOSFET devices are widely used in switching mode power supplies of PCs with relatively low withstand voltages (30 to 100 V).

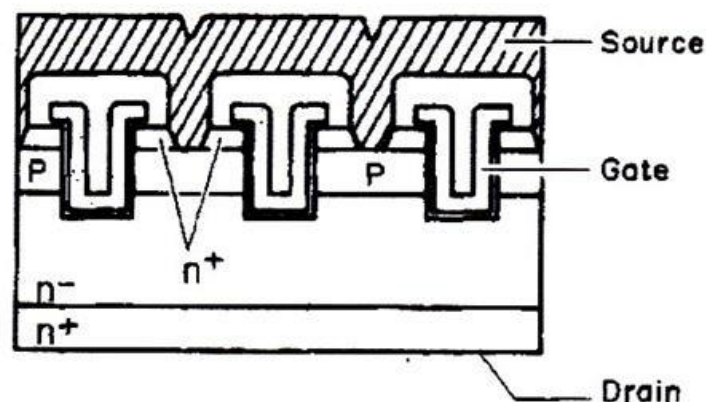


Fig.1: Cross sectional structure of UMOSFET

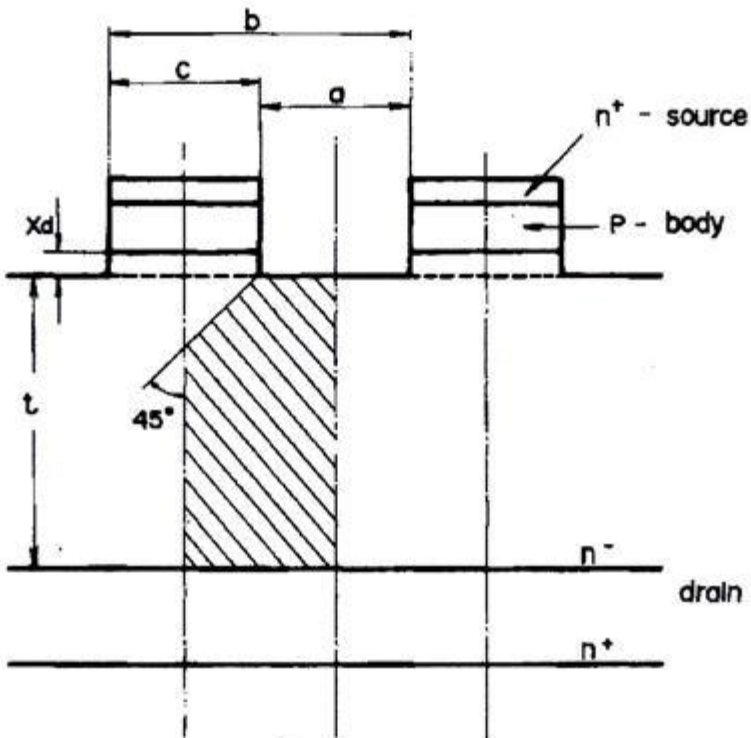


Fig. 2: Current path model for calculating ON-resistance of UMOSFET<sup>[1]</sup>

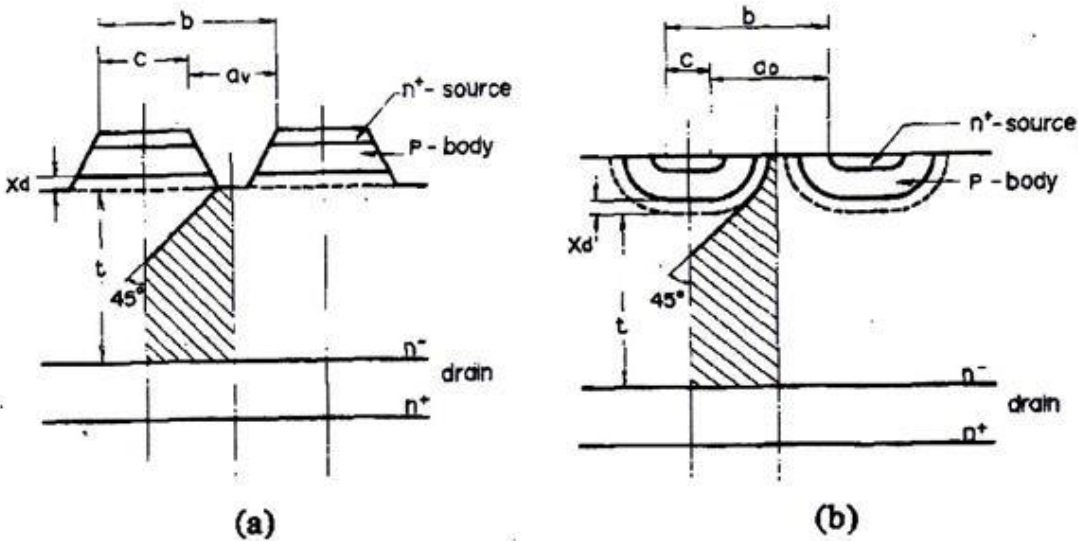


Fig. 3: Current path models for VMOSFET(a) and DMOSFET(b)<sup>(1)</sup>

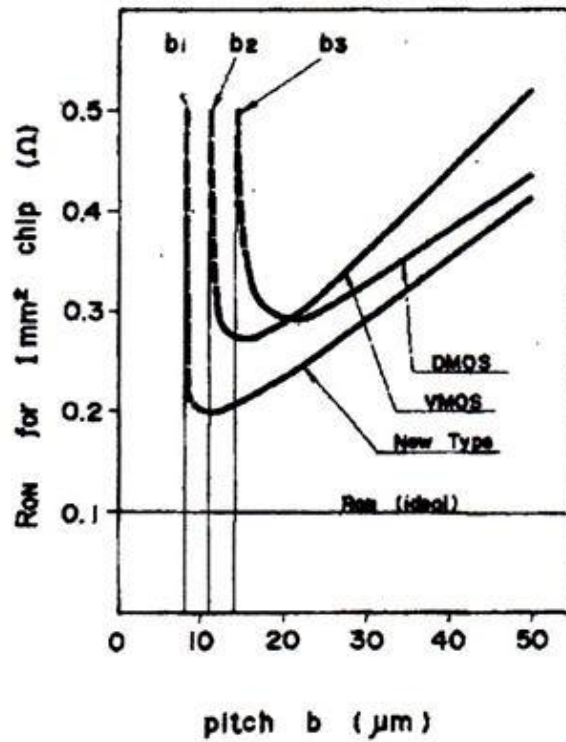


Fig. 4 Comparison of ON-resistances of UMOS (New type), VMOS, and DMOSFET [1]

Reference:

[1] D. Ueda, H. Takagi, & G. Kano, "A new vertical power MOSFET structure with extremely reduced on-resistance" IEEE Trans. Electron Devices, vol. ED-32, pp. 2-6, (Jan. 1985)

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