



## **1970s**

### **SRAM evolution**

**~ Integrated Circuit ~**

Bipolar RAM first appeared as a semiconductor memory in the latter half of the 1960s, and then Intel launched MOS SRAM in 1969. It was the PMOS 256-bit SRAM 1101. Intel subsequently released 1K bit NMOS SRAM and 1K bit CMOS SRAM.

In the 1970s, DRAM was developed as mainframe memory and SRAM as memory for peripheral devices and microcomputer systems. SRAM market at the time was 1/3 to 1/2 in size compared with DRAM, which was an important market.

SRAM was developed in two different segments, a medium speed SRAM with relatively large memory capacity, and a high-speed SRAM with small capacity. Intel was again the first company at this point to cut the front in high-speed MOS SRAM. Intel's 1K SRAM 2115 at that time achieved a high speed of 70 ns and competed with bipolar RAM. As the miniaturization advanced, the access time of MOS SRAM improved from 70ns to 55ns and 45ns, and bipolar RAM became specialized in super-high-speed field.

In an early CMOS SRAM field, Intel and Intersil were leading manufacturers, but then Japanese manufacturers entered the market and the development competition intensified. Toshiba developed the 1 Kbit CMOS SRAM TC5006P for the first time as a Japanese manufacturer in 1975. Toshiba further announced 4K bit CMOS SRAM at ISSCC in 1977. Characteristics of CMOS SRAM are low power consumption in operation. And it has battery backup function as well, being capable of holding data with batteries after the main power supply is turned off.

In 1978, TI released a 16 Kbit NMOS SRAM TMS4016, pin compatible with EPROM, and the era of 16 Kbit opened. In Japan, Hitachi launched CMOS HM 6116, and Toshiba also released CMOS TC5516. NEC, Fujitsu, Mitsubishi Electric and Oki Electric followed, and the competition became harsh. Japanese manufacturers surpassed the US makers in the 16K bit era, and the Japanese makers gained an overwhelming position in middle-speed SRAM, which was mainly covered by CMOS.

There were two types of SRAM memory cells at that time: 6 MOS type CMOS cell consisting of PMOS and NMOS, and 4MOS+2R cell type using high resistance.



Fig. 1K bit CMOS SRAM TC5006P by Toshiba