C-1-3

Bias Field Margin Degradation Due To Long-term Memory Operation In 16 k bit Bubble Memory Chip.

N.Yamaguchi
Musashino Electrical Communication Laboratory
3-9-11 Midori-chō Musashino-shi, Japan

This paper shows the effect of long-term memory operation stability on the control function in a 16 k bit capacity, 100 kHz rotating magnetic field, 2.7 ms access time bubble memory chip which is organized in major-minor loop configuration and is processed on $(YSm)_3(FeGa)_5O_{12}$ garnet wafer supporting 5 μm bubbles.

The 16 k bit bubble memory chip is shown in Fig.1.[1] The overall operating bias field margin was 7 Oe with 40 Oe rotating magnetic field. The bias field margin was degraded by the circuit failure, either bubble information loss or read error, which took place during long-term memory operation.[2]

Failures were measured by using a designed bubble memory exerciser. This exerciser operated the chip in a read or write mode, major loop propagation mode or the major-minor loop propagation mode, the control function pulse paramaters were varied, and the detector output information patterns were compared with the original input.

The failure rate in the major-minor loop propagation was in good agreement with that of the major loop propagation. The failure rate in a write read mode test was in good agreement with that of a read only test in the major loop propagation. Thus, the bias field margin were determined by replicator-annihilator and detector in long-term memory operations. It was found that the replicator-annihilator control function parameters are very important to obtain a good long-term stability in the memory operation. The replicator-annihilator and its control pulse program are shown in Fig.2.

The replicate-annihilate control pulse parameters were optimized to provide the longest $\overline{t_m}$ (MTTF: Mean Time To Failure) near the upper threshold or the lower threshold in the bias field margin, where $\overline{t_m}$ was the most effective factor for data longevity estimation.

For example, using parameter $\overline{t_m}$, replicator current phase and amplitude margin with 0.2 μs pulse duration near the upper threshold is shown in Fig.3. The $\overline{t_m}$ value at optimum condition A is about 10 times longer than the value at condition B.

Bias field margin degradation data in pulse parameter conditions A and B with 38 Oe and 43 Oe rotating magnetic field is shown in Fig.4, where λ means failure rate per one bubble read. The best bias field margin degradation

of -0.2 Oe/decade with condition A (Hr=43 Oe) was obtained. All the control function parameters were optimized to provide the longest $\overline{t_m}$ for the generator, transfer gate, as in the case of replicator pulse parameters optimized. Error-free memory operation in excess of 64 days and a read error rate of less than 7×10^{-12}/ read were demonstrated. No further adjustment were made during the test.

(1) M.Hiroshima et al,. IECE Conf. 1974, No 267.

(2) P.W.Shumate et al,. AIP Conf. Proceedings No 11 P 140.

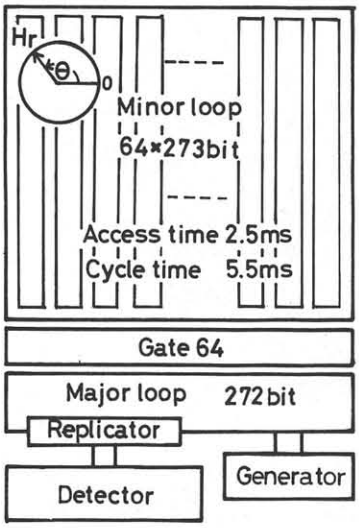

Fig.1 16 k bit bubble memory chip.

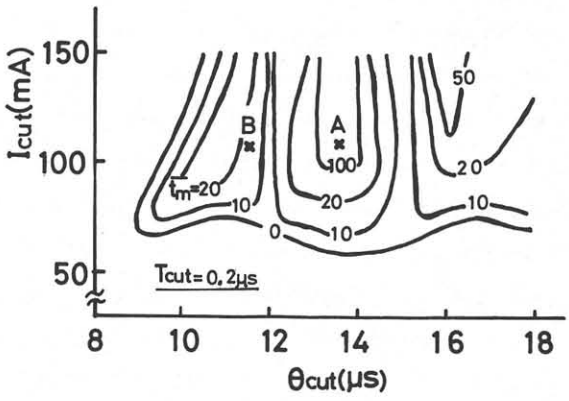

Fig.3 Replicate current phase θcut and amplitude margin Icut with 0.2 μs pulse duration near the upper threshold.

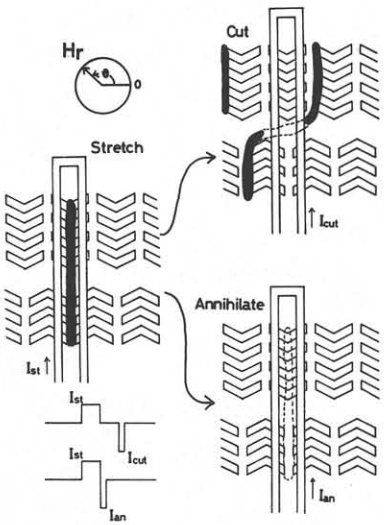

Fig.2 Replicator-Annihilator circuit and current pulse program.

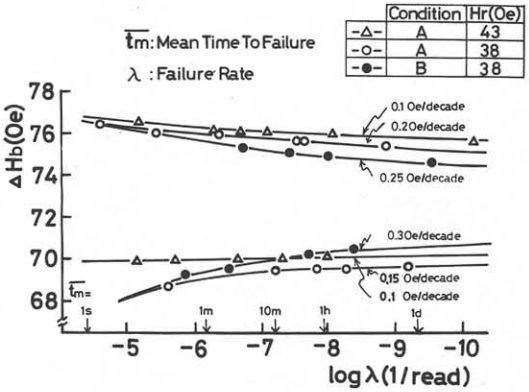

Fig.4 Bias field margin degradation data in 16 k bubble memory chip.