3 - 20 Heavy Ion Induced Single Event Upset in a Harden SOI SRAM

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In order to deepen the understanding of the difference between $0 \rightarrow 1$ and $1 \rightarrow 0$ sinle event upset (SEU) cross-section in a novel active delay element (ADE) SRAM (Static Random Access Memory) cell, the irradiation was carried out at Heavy Ion Research Facility in Lanzhou (HIRFL). Using the $^{86}Kr^{26+}$ ions irradiated the device under test (DUT) adopted partially depleted (PD) silicon of insulator (SOI) technology. The feature size of DUT fabricated by institute of microelectronic (IME) was 180 nm. The schematic diagram of SEU harden ADE-SRAM cell is shown in Fig. 1. The ADE is essentially a NMOS connected in only one of the feedback paths between the two inventors of the memory cell. It plays a role as switching transistor. Except during a write operation, when the switch transistor is turned on (so as not to compromise the write speed), the off-ADE provides a much greater RC delay between the two inventors of the memory cell to achieve much improved SEU hardness[1].

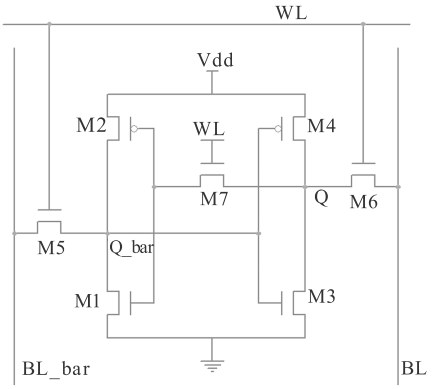

Fig. 1 The schematic diagram of ADE PD SOI SRAM.

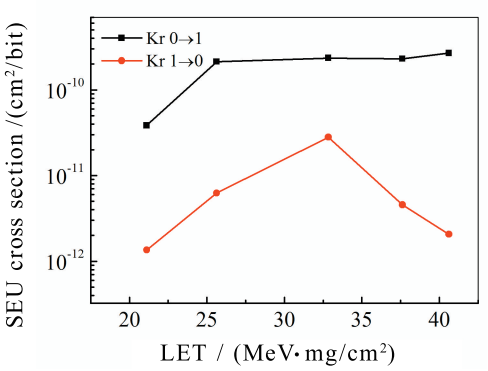

Fig. 2 (color online) The SEU cross-section in 180 nm ADE SOI SRAM.

The result is showed in Fig. 2. The solid black block represents the upset cross-section from 0 to 1. Between 21.11 and 25.63 MeV·mg/cm^2 of LET (linear energy transfer), the cross-section increases with the LET increasing. After that, it reaches saturation. This result is agreement with Weibull curve. However, the upset cross-section from 1 to 0 represented by the solid red circle shows significant difference with above. The curve appears a peak at the LET=32.84 MeV·mg/cm^2. It goes against Weibull curve. In fact, the ADE expected off is turned on by the leakage current from the word line in the standby model. Due to the difference of the RC delay time in the two feedback path, the SEU cross section between the $1 \rightarrow 0$ and $0 \rightarrow 1$ have a big difference. Why do the peak appear? Because a DH (Double Hit) machanism[1] proposed by Liu et al depends on the energy of strike particles strongly. So when the energy is less than a certain constant, the range of secondary particles produced by the nuclear interaction with primary particles and Si is not enough striking the double sensitive node at the same time. Although the LET increases, the cross-section decreases.

In conclusion, it is found that using the ADE-SRAM cell is lower one or two orders of magnitude about the $1 \rightarrow 0$ upset cross-section than $0 \rightarrow 1$ from the Fig. 2. So the structure is extremely important to the space mission, especially with the scaling down of feature size of technology node.

Reference

[1] M. S. Liu, H. Y. Liu, N. Brewster, et al., IEEE Trans Nucl Sci, 53(2006)3487.