the case of irradiation at 550℃, cavity size in the samples is much smaller than that of the former discussed. Some factors conspire to prevent the cavity growth[5]. On one hand, concentrations of the thermal equilibrium vacancies are higher, and supersaturated concentrations of the vacancies are partially vanished. On the other hand, the mobility of the vacancy-type defects is relatively higher, and vacancies can be easily emitted from the defect clusters, which lead to the recombination phenomena in the matrix.

Measurements and analysis yield the cavity swelling values illustrated in Fig. 4 in the peak damage regions of the irradiated specimens. On the whole, SIMP steel keeps relatively lower cavity swelling values at different irradiation temperature conditions.

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3 - 25 Preferable Multiple-bit Upset Patterns in Anisotropic SRAM Device

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Multiple-bit upset (MBU) occurs when the single energetic particle strikes a memory circuit and causes more than one bit to flip, as opposed to single-bit upset (SBU) in which only one bit is affected[1]. For static random access memory (SRAM) circuits, MBUs are particularly important since the MBU occurrence can limit the effectiveness of error correcting codes (ECC)[2]. With the technology downscaling, the rate of MBU increases due to the reduced spacing between adjacent cells, reduced critical charge and reduced individual cell dimensions. Thus, investigating and analyzing the mechanism of MBU is an increasing priority.

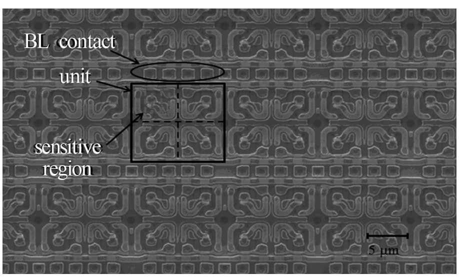


Fig. 1 SEM picture of the layout of IDT71256 SRAM cells. Every unit contains four memory cells. SEU sensitive region of the4-transistor, polysilicon resistor load SRAM cell is the drain of the off-transistor.

In the experiment, an IDT71256 32k×8 bits SRAM device was irradiated at HIRFL by using ^{40}Ar, ^{86}Kr and ^{209}Bi ions with initial energy of 25, 25 and 9.5 MeV/u, respectively. MBUs including double-bit upsets (DBU), triple-bit upsets (TBU) and quadruple-bit upsets (QBU) were detected and their patterns, which mean the physical arrangement of the bit-errors in a MBU, are shown in Tables 1～3, respectively. The majorphysical patterns of DBUs include two adjacent cells in a row, followed bythe occurrence of two adjacent cells in a column, and two cellsin diagonal (Table 1). This phenomenon can be explained by the anisotropiclayout of the SRAM cells, as shown in Fig. 1. Sensitive regions of adjacent cells have minimum distance horizontally, while vertically they are separated by bit-line (BL) contact. The preferable TBU and QBU patterns turn out to be the L-shaped and square-shaped configurations, respectively (Tables 2 and 3). The generated charge by single incident ion is more easily collected by multiple adjacent cells belonging to the same unit, than by farther nodes.

Table 1 DBU patterns induced by normally incident Ar, Kr and Bi ions with different LET values

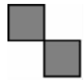
LET (MeV/(mg/cm^2))	DBU patterns			
				Others
13.6	76	25	0	0
28.1	112	74	16	0
31.8	119	78	13	0
40.7	163	81	21	0
100	110	38	17	1

Table 2 TBU patterns induced by normally incident Kr and Bi ions with different LET values

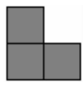
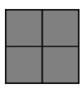
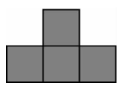
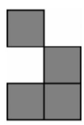
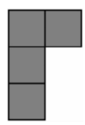
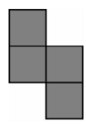
LET (MeV/(mg/cm^2))	DBU patterns			
				Others
28.1	51	0	0	0
31.8	64	0	0	0
40.7	76	0	0	0
100	111	4	1	2

Table 3 QBU patterns induced by normally incident Kr and Bi ions with different LET values

LET (MeV/(mg/cm^2))	DBU patterns					
						Others
28.1	7	0	0	0	0	0
31.8	4	0	0	0	0	0
40.7	8	0	0	0	0	0
100	15	10	5	5	3	4

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