5 - 20 Luminescence Characteristics of $\beta$-Ga$_2$O$_3$ Irradiated by Swift Heavy Ions

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$\beta$-Ga$_2$O$_3$ has received extensive attention as power electronics and UV optoelectronics because of its ultra-wide band gap, excellent chemical and thermal stability. In this work, $\beta$-Ga$_2$O$_3$ single crystal was irradiated by 590 MeV Kr ions with the surface $S_e$ value of $\sim$17.3 keV/nm. The luminescence characteristics of $\beta$-Ga$_2$O$_3$ samples before and after irradiation were studied by photoluminescence (PL) and photoluminescence excitation (PLE) at room temperature. PL results show that the emission peak gradually decreases upon Kr ion irradiation as compared with the as-grown sample, which indicates a quenching effect of PL intensity induced by irradiation defects in $\beta$-Ga$_2$O$_3$ samples. The corresponding PLE results confirm that the PL emission at 360 nm (3.4 eV) reveals two bands of 265 nm (4.7 eV) and 275 nm (4.5 eV), which are due to intrinsic absorption of band gap and defect absorption of defect energy level, respectively. Compared with the intrinsic absorption, the proportion of defect absorption of irradiated samples increases gradually. According to our previous study[2], amorphous latent tracks can be generated in $\beta$-Ga$_2$O$_3$ single crystal under the $S_e$ value of Kr ions in this experiment. Therefore, it can be speculated that the amorphous latent tracks will not only reduce the luminous intensity of $\beta$-Ga$_2$O$_3$ single crystal, but also enhance the photo excitation efficiency of defect energy level. This requires further confirmation by TEM.

References


5 - 21 Geant4 Simulation of Neutron-induced Single Event Upset in a Three Dimension Die-stacked SRAM

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In the fields of commercial aerospace, earth orbit satellite, Mars exploration, and aviation, the single event effect (SEE) caused by neutron has attracted much attention in recent years. 3D ICs are increasing favored aerospace, aviation, and ground applications due to its higher integration, less weight, better electrical performance, less power
consumption, lower profile, and higher throughput compared to 2D ICs. The sensitivity of 3D ICs to SEE is also a major concern and consideration for radiated harden filed\cite{1,2}. In this work, we employed the Geant4 simulation tool\cite{3} constructing a 3D die-stacked device model to simulated and analyzed the single event upset (SEU) sensitive of the 3D device.

The 3D SRAM simulation model was established a three-layer stacked device model based on the single-layer SRAM model in Ref. \cite{3}, which is indicated in Fig. 1. The size of model cube is $12 \mu m \times 25 \mu m \times 23.7 \mu m$, and each die includes $25 \times 25$ SRAM cells. The first and the second layer dies are bonded face to face structure, and the third layer die is boned back to face structure with the second layer die.

![Fig. 1](color online) The simulation model of 3D die-stacked SRAM. Die1 and Die2 are bonded face to face structure, and the Die3 is boned back to face structure the Die2.

The SEU cross-section ($\sigma$) with the unit of $cm^2$/bit was calculated by the following equation, which is the same as presented in our previous reported\cite{4}.

$$\sigma = N/(f \times 625 \times L).$$

Where $N$ is the number of recorded upsets in each simulation, $F$ is the total fluence of neutron in unit neutrons/cm$^2$, and $L$ is the number of die layers of the device. $L = 1$ refers to the single-layered die device and $L = 3$ the whole three-layered die-stacked device model.

The upset cross sections of the Die1, Die2, Die3 and the whole three-layer die-stacked as a function of neutron energy for 3D SRAM are presented in Fig. 2. The upset cross section for different layer die and the whole three-layer die have the consistent overall trend. All the neutron with energy in the range of 1 to 1 000 MeV has the possible to induce SEU in the electronic device. At 14 MeV, the upset cross section reaches one of the extreme values, which is about one order of magnitude higher than the low-energy region, and then it reduce. Subsequently, the upset cross section slowly increases as the energy increasing and the level is the same as 14 MeV, ultimately.

The results show that there is a difference in neutrons caused SEU cross-section between the single layer device and 3D die-stacked device in low energy area. The Die3 has the higher upset cross section compare the Die1 and Die2, which is obvious for the neutron energy less than 14 MeV and the gap is reducing as the neutron energy increases.

References