CO10-1 Damage of USB Semiconductor Memory by Radiation Exposure

J. Takada, K. Tanaka and Y. Sakurai[1]

Center of Medical Education, Sapporo Medical University
[1]Research Reactor Institute, Kyoto University

INTRODUCTION: Quantitative evaluation of the radiation effect on the semiconductor equipment is meaningful in estimating the damage of the nuclear disasters and planning how to defense the damage [1]. Our group has been working on evaluating this radiation effect [2]. This document reports what was done in 2010.

EXPERIMENTS: The irradiation was performed with Kyoto University Research Reactor Institute Heavy Water Neutron Irradiation Facility (KUR-HWNIF), rail transporting device. The utilized mode was standard mixed neutron irradiation mode (OO-0000-F). USB storage media the pocket bit mini (2 G byte, made by SONY corporation) as a semiconductor memory element.
Some elements were connected with PC outside the irradiating room through the USB cable of 5m in length, the USB hub, and the repeater cable of 5m in length. They are tested as to reading and writing the date in them. This is called 'active' irradiation. On the other hand, other elements were irradiated without connecting to the PC. This is called 'static' irradiation.
The dose rate of the irradiation was set at 0.057 to 1.52 Gy/h by adjusting the distance between the distance of the element and irradiation aperture on the Bi surface, at 0 to 150 cm. The neutron dose at the distance 0cm, the contribution to the dose is 56 % for the neutrons and 44 % for the gamma rays. The neutron component decreases with increasing distance. At 150 cm distance, the contribution is 12 % for the neutrons and 88% for the gamma rays. For both active and static irradiations, the data in the elements are copied to the PC after irradiation and compared with un-irradiated data. Through this test, the correctness of copying was examined. As to the active irradiation, the test was conducted during the irradiation as well.

RESULTS: The trouble observed in the experiment was failure in copying (soft-error), temporary disconnection between the element and the PC (access instability), and continuous disconnection (access failure). The soft error was observed at only 2 dose rates of 0.0853 to 0.114 Gy/h, with the dose below 0.151 Gy.
The access instability and access failure were observed at several dose rates. Figure 1 shows the value of the dose that causes the above-mentioned troubles. The values are the total of the doses by neutrons and gamma rays. The width of the dose region where the trouble starts to occur is different for each dose rate. This is because the dose points at which the irradiations were stopped are different for each dose rate.
Though the number of the elements are as few as 1 to 3 for each dose rate and irradiation style, i.e. active or static, the troubles such as access instability and access failure was observed when the dose was 0.01Gy or more (neutron contribution 10 to 50 %). However, the soft error was also observed among the data copied from the irradiated elements. In nuclear disasters, the defense against those data change is necessary.
In the condition in the present study, it is thought that the semiconductor memory can prevent trouble if the dose is regulated and controlled at the same level as the human beings. On the other hand, this result suggests that the frequency of the errors in the semiconductor memory would be usable as a scale to estimate the exposure dose to human being in the vicinity of the memory Similar experiments with the standard epithermal neutron irradiation mode are now ongoing.

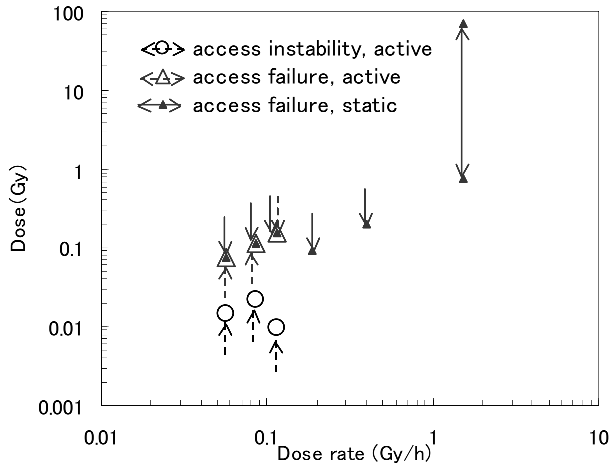

Fig. 1. Dose causing error dependent on dose rate

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