SHIELDS OF LOCAL PROTECTION FOR SEMICONDUCTOR DEVICES AGAINST OUTER SPACE ELECTRON RADIATION

D.I. TISHKEVICH, S.S. GRABCHIKOV*, S.B. LASTOVSKII*, D.S. VASIN**, A.S. YAKUSHEVICH*, A.V. TRUKHANOV**

**SSPA "Scientific and Practical Materials Research Centre of NAS of Belarus", P. Brovki str., 19, Minsk, 220072, Belarus, dashachushkova@gmail.com, +375295628187*

***Belarusian State University of Informatics and Radioelectronics, P. Brovki str., 6, Minsk, 220013, Belarus*

Nowadays, the maintenance of high indicators of devices and equipment operational reliability in the raised level of radiation influence conditions (electrons, protons, heavy charged particles, X-ray and gamma radiation) is very actual. Currently, the problem of radiation resistance increasing is solved by several methods: technological (specialized technological processes and materials), constructive (specialized packages, methods of local protection), schematics (majorization methods, etc.) and method for radiation defects modeling of integrated microcircuits at the design stage. The widely used material for radiation protection is lead, but it is a toxic material with a high density and a low melting point value. In this regard, the problem of replacing lead with other more environmentally friendly and effective materials in terms of its mass-dimension parameters is very relevant.

Samples of shields based on $W_{77,5}Cu_{22,5}$ composite in the form of plates with 20×20 mm^2 size and 0.6, 0.9, 1.2 and 1.5 mm thicknesses were obtained by solid-phase synthesis method. Samples radiation using a linear electron accelerator ELA-4 was carried out. A duralumin plate of 5 mm thickness was placed between the target and the electron output window to approximate the accelerator ELA-4 electron spectrum characteristics to the spectrum of electrons of the Earth's radiation belt (E_e=1.6-1.8 MeV).

The shielding efficiency was evaluated by estimating the behavior of the volt-ampere characteristics (VAC) of test n- and p-MOS transistors (MOST). The shielding efficiency coefficient values (the attenuation coefficient) (Ka) were simulated from ratio (1)

$$K_a = F/F_0, \qquad (1)$$

Where F – the electron fluence corresponding to a parametric failure of a shielded test MOST;

F_0 – the electron fluence corresponding to a parametric failure of unshielded test MOST.

The parametric failure of MOST was fixed with threshold voltage changing ΔU = 0.1 V.

The results of protected and unprotected n- and p-MOST by shields under electron irradiation with 1.8 MeV energy in the passive electric mode, are shown in Figure 1. For all test MOST, ΔU growth in the whole electron radiation fluences investigated range is observed. However, the same ΔU values of protected and unprotected n-MOST are obtained in case of protected n-MOST, but with radiation fluences in two orders higher than for the case of unprotected n-MOST. The use of protective shields in hundred times or more reduce the speed of p-MOST parameters degradation under electrons irradiation. Data analysis shows that the excessive thickness build-up of the $W_{77.5}Cu_{22.5}$ shields does not give a clear advantage in the radiation protective properties of shields. Apparently, this is due to the presence of braking radiation, which has a greater penetrating power. In this connection and, proceeding from the requirements of minimization of mass-dimension parameters, the most optimal thicknesses of $W_{77.5}Cu_{22.5}$ shields are 0,9÷1,2 mm values.

№	Shield thickness d, mm	Attenuation coefficient K_a	
		n-MOST	p-MOST
1	0,6	123	96
2	0,9	130	130,8
3	1,2	165	142,3
4	1,5	140	155,8

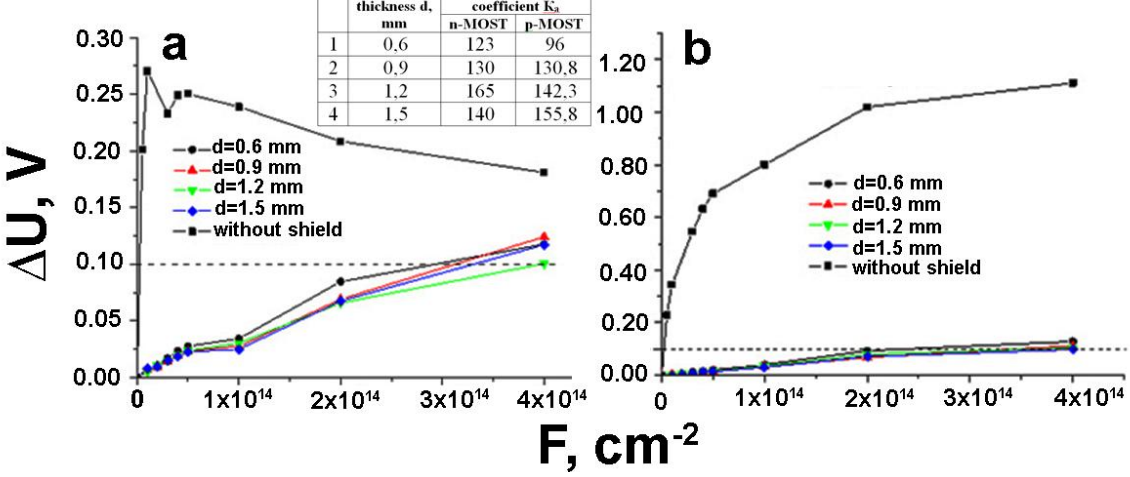

Fig. 1. Dependences of the n- (a) and p-MOST (b) voltage variation on the electron radiation fluences without and with shields with different thicknesses.