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EFFECT OF SUPERDEEP PENETRATION (PUNCHING OF OBSTACLES) AND ITS INFLUENCE ON THE OPERATION OF ELECTRONIC ELEMENTS

S. M. Usherenko,[a] G. S. Romanov,[b] O. A. Dybov,[a] A. I. Belous,[c] and S. V. Shvedov[c]

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Recording of the influence of the flux of high-velocity particles in the regime of superdeep penetration on the operating parameters of microcircuits placed behind a thick-walled obstacle is reported for the first time. It is proposed that this effect is possible in collision of a micrometeorite flux with a spacecraft, which can have an effect on the operation of its computer equipment.

The effect of superdeep penetration implies penetration of a flux of high-velocity particles, in the case of their collision with a metal obstacle, to an obstacle depth of hundreds of millimeters [1].

The velocities of the particles are ≈1000 m/sec and their diameters are up to hundreds of microns. The density and the dimension (length) of the flux are critical. The track formed in the obstacle is a partially or completely collapsed channel. When the collapse is complete, it is revealed in the form of zones of the obstacle material of higher-than-average capacity for etching. The particle material is fixed at certain sites on channel walls or inside them. No open porosity and hence permeability of the obstacle are formed. The channel diameter is tens or hundreds of times smaller than the particle diameter. The effect is inherent in both metal particles and ceramic (cermet) ones. The x-ray film placed in the bulk of the obstacle records the occurrence of periodic narrow-band x-ray radiation in collision with the particle flux [2].

We can assume that the effect of superdeep penetration will also exist in collision of metal bodies, including the structural elements of spacecraft, with the clusters of micrometeorites (particles) existing in space. In this case, there must be punching of the skin of the spacecraft (without its decompression) and some action exerted on the electronic equipment, in particular, and what is more significant, the computer equipment distinguished by a high degree of integration. The action can be both mechanical (the action of the particle material) and pulsed (x-ray). There can be the variant not of a complete failure but of a change in the regimes and of subsequent failure in the operation of the equipment. In our opinion, the emerging reports on troubles in the operation of the onboard computers of the space station confirm the manifestation of the effect of superdeep penetration in collision with the fluxes of unrecorded micrometeorites.

To confirm or deny the assumption we qualitatively checked the possibility of action, on the operation of electronic devices (microcircuits of a high-speed complementary MOS logic), of the material of particles upon punching of 100- and 200-mm-thick steel obstacles by them (i.e., the microcircuits were protected from the particle flux by a steel casing of thickness 100 and 200 mm).

A comparison of the tested parameters of the microcircuits before the action of the particle flux and after it has shown a change of 25–80% in some of them.

The experimental data obtained can serve as the first partial proof of the above assumptions; this makes the problem of investigating the physical mechanism of degradation of the electroparameters of the integrated microcircuits of spacecraft under the action of microparticle fluxes and the development of methods for improving the stability and protection of the electronic element base of spacecraft quite pressing.

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[a]Scientific-Research Institute of Pulsed Processes with Pilot Production, Minsk, Belarus; email: impuls@bn.by; [b]A. V. Luikov Heat and Mass Transfer Institute, National Academy of Sciences of Belarus, Minsk, Belarus; [c]"Integral" Scientific and Production Association, Minsk, Belarus. Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 75, No. 6, p. 7, November–December, 2002. Original article submitted June 17, 2002.

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