Contamination of protective coatings of spacecraft solar arrays due to electrostatic discharges under electron irradiation

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Functioning of spacecraft is accompanied by changes of the state of their outer surfaces that are induced by damages under destructive factors of space environment and by deposition of contaminations.

In particular, the dielectric materials of the outer surfaces of high-orbit satellites accumulate charges under the effect of ionizing radiation, which causes the appearance of surface potentials and strong electric fields resulting in electrostatic discharges (ESD) with a current amplitude of up to hundreds of amperes and nanosecond leading edges; they interfere with the work of on-board equipment, can cause the destruction of materials and contamination optical surfaces [1]-[3]. Thus ESD on the surface of a solar array may cause a gradual decrease in the solar array efficiency, electronic equipment malfunctions, and contamination of sensitive devices.

Spacecraft contamination results mainly from the condensation of molecular species which are outgassed by spacecraft materials. Such contaminations can cause the degradation of optical properties of spacecraft outer skin [4]. Special attention should be paid to contamination deposits that are formed from intrinsic outer atmosphere of spacecraft with participation of trapped and solar ionizing radiation.

Electrostatic discharges observed upon the electron irradiation of K-208 and CMG glasses, used as protective coatings for the solar cells of spacecraft, were previously studied [5], [6].

In the paper, we consider the effect of structural changes of K-208 and CMG glass surfaces due to the radiation-induced ESD on contamination caused by outgassed products imitating the components of spacecraft outer atmosphere.

We have proposed a new route for contaminant fixation on the protective coatings of spacecraft solar arrays due to ESD under electron irradiation. It was shown that the morphology of K-208 and CMG glasses changes under the electron irradiation in vacuum as a result of the appearance of microprotrusions and discharge channels, deposition of plasma ions and positively charged clusters that return to glass surface after discharge, precipitation of the residual atmosphere components in the vicinity of discharge traces. These effects may cause a degradation of the solar array efficiency and electronic equipment malfunctions.

REFERENCES