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PHYSICAL SIMULATION OF THE INTERACTION OF SPACECRAFT WITH PLASMA FLOWS AND ELECTROMAGNETIC RADIATION FLUXES IN THE EARTH'S IONOSPHERE

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This paper briefly overviews the results of the investigations into problems of physical simulation of spacecraft – ionospheric plasma interaction and spacecraft exposure to a complex of space factors conducted at the Department of Ionized Media Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine. Physical simulation is an efficient means to reproduce the spectrum of the basic processes and phenomena that accompany the spacecraft operation in orbit and are initiated by exposure to the complex of space factors, especially to hypersonic rarefied plasma and atomic oxygen flows and solar ultraviolet radiation. To simulate the spacecraft operation conditions in the ionosphere at altitudes of 150 km to 40,000 km, a plasmalelectrodynamic setup was developed and made. The setup combines the properties of a plasma wind tunnel and a vacuum anechoic chamber. The setup served to conduct investigations as part of scientific programs and the development and operation of a number of space hardware products. The distortion of radio reflections from spacecraft structural elements by artificial plasma formations was studied. Processes of radiative electrization of spacecraft structural components were studied. Techniques were developed for accelerated life tests of polymer and composite materials under exposure to atomic oxygen flows and vacuum ultraviolet radiation. Physical simulation based on accelerated life tests allows one to reproduce the conditions of a long-term spacecraft operation: the behavior and degradation of the electrophysical, thermo-optical, energy, and mass-and-dimension characteristics of spacecraft structural materials and coatings. Solar battery exposure to the complex of near-satellite environment factors, which results in power loss and a shorter life, was simulated. The resulting spacecraft material property and system operation degradation rate vs. space factor exposure time relationships allow one to predict the spacecraft material, structural component, and technical system state at any time during the spacecraft operation and may be used at the spacecraft design stage.

Keywords: *spacecraft, ionosphere, plasma, physical simulation, plasmalelectrodynamic setup.*

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