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DEVELOPMENT OF A GROUND-BASED METHOD FOR TESTING THE INTERACTION OF MATERIALS WITH HIGH-SPEED DUST PARTICLES

Abstract

Collisions of spacecraft with solids of natural and artificial origin are among the most important factors causing damage and destruction of spacecrafts. Collision velocities of spacecraft with meteor bodies and space debris objects are in the range of 1-70 km/s. Solid particles with transverse dimensions less than 1 mm (cosmic dust) can be considered as a factor constantly affecting spacecraft, characterized by their flux density. According to available data for low Earth orbits (altitude 300-1000 km), the flux density of particles with a transverse size of less than 10 microns is two to three orders of magnitude higher than the flux density of micrometeoroids. Studies have shown that at such collision speeds intense energy release occurs in a limited volume of the substance, accompanied by the formation of shock waves with subsequent mechanical damage, melting, evaporation and plasma formation, appearance of electromagnetic radiation that can turn off nearby electrical equipment. Existing spacecraft shields do not provide reliable protection cause for a long time, the collisions of streams of dust particles with metal modules of spacecraft were considered only from the position of erosion of the outer surface. An expensive task is to conduct field tests of the protective properties of various materials; therefore, computer simulation is often used which cannot always ensure full compliance with real conditions. Using the method of dynamic loading of a material with a high-speed stream of powder particles (in SDP mode) provide a simple and effective way to test the behavior of materials and electronic systems in ground-based conditions. Super-deep penetration (SDP) is a complex physical phenomenon, when in a split second stream of powder particles with a fraction less than 200 microns, accelerated to speeds of 700-3000 m/s, penetrates into the solid metal body at depth in tens, hundreds mm. Experimental studies of the effect of dynamic loading in the SDP mode on aluminum and steel have already shown that the effect changes the physical and mechanical properties of materials. The study of the behavior of materials under the influence of a high-speed stream of powder particles will make it possible to use these data in the future for the development of a new generation of protective shells for spacecraft. Creation of protective shells that provide protection not only from micrometeorites, but also from high-speed cosmic dust and electromagnetic radiation will reduce the cost of developing and launching devices, expand the range of equipment created.