ISSN 0040-6015, Thermal Engineering, 2012, Vol. 59, No. 13, pp. 975–980. © Pleiades Publishing, Inc., 2012.
Original Russian Text © V.A. Bogushevskaya, B.V. Zhalnin, O.V. Zayats, Ya.N. Maslyakov, I.S. Matsak, A.A. Nikonov, Ye.V. Obrucheva, V.Yu. Tugaenko, 2012, published in Izvestiya RAN. Energetika.

An Experimental Investigation of the Feasibility of Using Silicone and Gallium Arsenide Solar Batteries on Space Vehicles for Receiving Energy of Laser Infrared Emission

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Received September 15, 2011

Abstract—The feasibility of transmitting electric power in space to solar batteries of space vehicles via the channel of laser infrared emission is shown. Evaluation of the efficiency of solar batteries for the given type of power transmission has been made. Possible methods of optimizing the design of space solar batteries in regard to conditions of detection of energy of laser infrared emission have been discussed.

DOI: 10.1134/S0040601512130034

INTRODUCTION

The needs of today's space vehicles for electric power supply grow steadily, and at the present time, they may be as much as tens of kilowatts. Technologies of space solar power systems make it possible to develop space vehicle power plants with a power output of hundreds of kilowatts, while nuclear space power systems can produce megawatts of electric power. On the International Space Station (ISS) their "own" power plant with the output of more than 200 kW has been created, and, according to the project of a logistics-and-power space module that is being developed in Russia, the power output of several megawatts is planned.

In the case of the availability of an efficient channel of power transmission between space vehicles, it would be correct to implement with respect to the cosmos, the concept of large power systems similar to the concept used in the terrestrial power sector, namely, to separate functions of generation and consumption of electric power among different space vehicles. At the Korolev Rocket and Space Corporation Energia consideration is being given to the technology of wireless power transmission between space vehicles based on laser IR emission [1]. The system of wireless power transmission is composed of a space vehicle—power supply module that generates electric power and transmits it by means of the laser to a space vehicle—consumer, on board of which the detector–converter is installed that converts energy of laser stimulated emission to electricity. The IR channel is used for transmitting electric power on the basis of the fact that in this region of the electromagnetic spectrum efficient enough (with the efficiency higher than 50%) detectors and transmitters of energy have been developed, and relatively small wavelengths make it possible to transmit power over distances of tens of thousands of kilometers without diffraction distortions of a wave beam using technologies of creation of detecting-and-transmitting systems with characteristic dimensions of their components as large as 10 m; such technologies have already been developed.

The most important stage in developing any one new space technology is to carry out space demonstration experiments intended to confirm the correctness of a choice of basic engineering solutions and the feasibility of the technology being developed under natural conditions.

Energia plans to prepare and conduct a series of space experiments on wireless electric power transmission between space vehicles using the Russian segment of the ISS and the Progress space vehicle. At the first stages dedicated to the further development of the methods of generation of an IR wave beam and its guidance on the detector, it seems worthwhile to examine the feasibility of power transmission to solar batteries mounted on a space vehicle.

The purpose of the investigation of operation of receiving solar batteries is to clarify the following questions:

—whether is it possible, and with what efficiency, to use standard space solar batteries as a detector–converter of laser emission to fit the system of wireless power transmission;

—how the nonuniformity of illumination of the surface area of a standard space solar battery affects the conversion efficiency;