

EFFECT OF LONG-TERM EXPOSURE TO LEO SPACE ENVIRONMENT

by

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Recent experience with Shuttle flights has shown that certain materials, particularly those of a polymeric base used externally for thermal control, are greatly effected by even short exposure to the environment of low Earth orbit. Since the performance of many of these materials can be crucial to the successful completion of the satellite mission, this discovery has lead to several short-term experiments conducted during Shuttle flights to attempt to characterize the phenomenon of degradation by atomic oxygen. However, since these experiments have generally been designed to maximize the fluence of atomic oxygen over a period of only hours, they effectively constitute accelerated tests, particularly in relation to other environmental effects which are not enhanced. Accordingly, one must be cautious to ensure applicability of the results to a more realistic situation that might occur at higher altitude, for example, where the increased presence of other environmental effects relative to atomic oxygen fluence may lead to enhanced or synergistic degradation. Fortunately, the success of in-orbit repair of satellites from the Shuttle has also provided some long-term exposure data in order to validate experimental data. The most celebrated of these data come from components and materials returned from the Solar Max Satellite Repair Mission.

In the present paper, data obtained from components and materials from the Solar Max Satellite are presented and compared to data for similar materials obtained from the Advanced Composite Materials Exposure to Space Experiment (ACOMEX) flown on Shuttle mission STS-41G. In addition to evaluation of surface erosion and mass loss that may be of importance to very long-term missions, comparison of solar absorptance and thermal emittance measurements for both long and short term exposures were made. Although the ratio of absorptance over emittance can be altered by proper choice of materials to ensure a proper operating environment for the spacecraft, once the thermal design is established, it is important that the material properties not change in order to maintain the operating environment for many payload and bus items such as electronics, batteries, fuel, etc. However, data presented show significant changes after short exposure in low Earth environment. Moreover, the measured changes are shown to differ according to the manner of exposure i.e. normal or oblique, which also affects the resultant eroded surface morphology. These results identify constraints to be considered in development of flight experiments or laboratory simulation testing.