IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

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INFLUENCE OF POST-BUCKLING BEHAVIOR AND MANUFACTURING ERRORS ON THE ACCURACY OF SPACE-TENSIONED THIN-FILM ANTENNA

Abstract

The flexible tension film deployable antenna is a large deployable space antenna with broad application prospects, which combines flexible electronics, flexible film materials, flexible structure, and flexible deployment technology. The flexible beam features can effectively meet the special needs of remote sensing, communications, and deep space exploration satellites. A typical space-tensioning thin-film phased-array antenna consists of multiple layers of rectangular film with parabolic boundary conditions, which are unfolded and maintained by a catenary-tensioning system to maintain the film surface accuracy. The film structure has a significant post-buckling response. The post-buckling response of a space-tensioning thin-film antenna is analyzed with respect to the variable stiffness characteristics of the space-tensioning thin-film antenna. Specifically, the analysis uses the eigenvalue buckling analysis and imperfection perturbation method. The manufacturing, processing, and assembly errors of the space antenna have an impact on the antenna's operation in orbit, and the modeling method of the manufacturing and processing errors of the antenna is investigated based on fractal theory. The fractal theory provides new distribution patterns for manufacturing errors. The applicability of the fractal theory was explored. Based on the research above, the effects of post-buckling behavior and manufacturing and processing errors on the antenna performance are calculated separately. Results show the characteristic of shape deformation under post-buckling and manufacturing errors. The explanation of the characteristic was discussed. With respect to the characteristic of space-tensioning thin-film phased-array antenna, a new diagram of the tension system was accomplished with the aim of reducing possible out-of-plane deformation.