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DUST MITIGATION ON MARTIAN SOLAR PANELS: A SYNERGISTIC APPROACH USING AEROGEL COATINGS AND ENVIRONMENTAL DYNAMICS

Abstract

Solar panels function as an essential energy source for Mars rovers and landers. However, dust accumulation remains an ongoing challenge, decreasing efficiency by 0.05% to 2% per Martian day. This study examines a multi-faceted dust mitigation technique combining state-of-the-art materials, mechanical vibration methods, and Martian environmental dynamics. Aerogel coatings are proposed to lower dust bonding—this is a novel proposal, as no previous studies have conducted research on aerogel in this context. Additionally, vibrational cleaning methods such as Chladni patterns are reviewed for their potential effectiveness. Optimizing solar panel inclination angles is also believed to minimize accumulation. Furthermore, Martian weather phenomena, including dust storms and wind vortices, are studied for their potential in passive cleaning. Proof of these approaches will involve real-life aerogel tests, computer-generated simulations, and experimental evaluations. By combining theoretical analysis with practical testing, this study seeks to develop a useful and sustainable solution for improving the longevity and efficiency of Martian solar panels, ultimately supporting the success of future Mars missions.