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Introduction: Space Environmental Effects on Materials

WE are pleased to bring you this second special edition of the *Journal of Spacecraft and Rockets*, titled Space Environmental Effects on Materials. The first edition of Space Environmental Effects on Materials was published in Volume 41, Number 3, May–June 2004, and included papers that were selected from the presentations at the 6th International Conference on Protection of Materials and Structures from Space Environment (ICPMSE-6) in Toronto, Canada, in 2002. Likewise, the papers in this edition were selected from the 7th International Conference on Protection of Materials and Structures from Space Environment (ICPMSE-7) that was held again in Toronto, Canada, in 2004. The ICPMSE series of meetings started in 1991 and has become an important part of the space environment community. Since its inception, the meeting has grown steadily, establishing itself as the only North American event covering the various aspects of materials protection in low Earth orbit and attracting a large number of engineers, researchers, managers, and scientists from industrial companies, scientific institutions, and government agencies in Canada, the United States, Asia, and Europe, thus becoming a true international event. The authors gratefully acknowledge the cooperation of Kluwer Publishing in granting permission for these selected papers to be published by the AIAA. The complete set of papers presented at ICPMSE-6 and ICPMSE-7 and earlier meetings can be obtained either from Kluwer Publishing as hardcover Conference Proceedings or from J. Kleiman. This special edition of the *Journal of Spacecraft and Rockets* will present papers detailing the effects of natural and induced space environments on spacecraft materials. The number of selected papers for this special edition was sufficient to warrant two issues.

Survivability of materials operating in the space environment remains a principal issue in the development of space systems and in most cases is assessed by the length of time their engineering performance requirements are met while on mission. Present and future space missions are increasing in complexity. Destinations, operational objectives, and mission duration stimulate today's spacecraft engineer to develop robust space systems that will survive the mission's natural space environment. Natural space operating environments of high vacuum, thermal cycling, charged particle radiation, ultraviolet radiation, atomic gas species, plasma, and micrometeoroids all pose a potentially mission-ending threat to spacecraft. Orbital debris, although not specifically a natural environment, must be considered a serious threat to spacecraft in Earth orbit. Additionally, space systems produce an induced environment near the spacecraft. Typically, this induced environment results from a venting incident from the space system or a volatile material out gassing in thermal vacuum. Outgassing volatiles and particulates from venting events tend to redeposit on spacecraft external surfaces, as a contaminant layer. Spacecraft materials are often subjected to a synergistic exposure of both the natural and induced environments. Several papers in this special section address contaminant deposition and photodepositon effects on spacecraft surface properties.

Today's mission designers are presented with the challenge of operating within the Kuiper belt, landing and operating manned and robotic craft on lunar and Martian surfaces, conducting science missions at the Lagrange points, and exploring the Jovian icy moons. Each of these environments is uniquely different, and will present its exclusive deleterious effects on spacecraft materials. Spacecraft engineers must constantly strive to develop increasingly robust materials and systems and innovatively mitigate these stringent environmental effects to increase the longevity of spacecraft functional life. Verification and validation of these mitigation techniques come both from the ground-based laboratories and on-orbit, in laboratories such as the International Space Station.

The papers in the first issue concentrate on characterizing the effects of vacuum ultraviolet radiation and atomic oxygen on specific properties of materials. The material properties influenced the most include material outgassing, erosion, and subsequently contaminant deposition due to external influences. Materials investigated and discussed in this section include silicones, polymers, and composites.

The second issue in this special edition will focus attention on the effects of charged particle radiation on spacecraft materials and systems. Exposure of photovoltaics, thermal control coatings, glass, and composites to electron and proton irradiation are all discussed in this issue. Several authors provide intriguing arguments to define damage mechanisms in selected materials attributable to radiation exposure. Also included in the second issue are papers specifically addressing materials and systems integration to the International Space Station. Real experiences, ranging from in-space water dumping interacting with surfaces to thruster plume erosion of solar array coatings, are discussed.

Each issue in this special edition offers a distinctive perspective on aspects of the space environment and their effects on material and system performance. The intent of this special edition is to disseminate, to a large audience, the understanding of the importance of space environment interaction with materials and provide guidance with specific cases of survivability, failure, and mitigation techniques to achieve mission success.

David L. Edwards
Associate Editor

Jacob Kleiman
Guest Editor