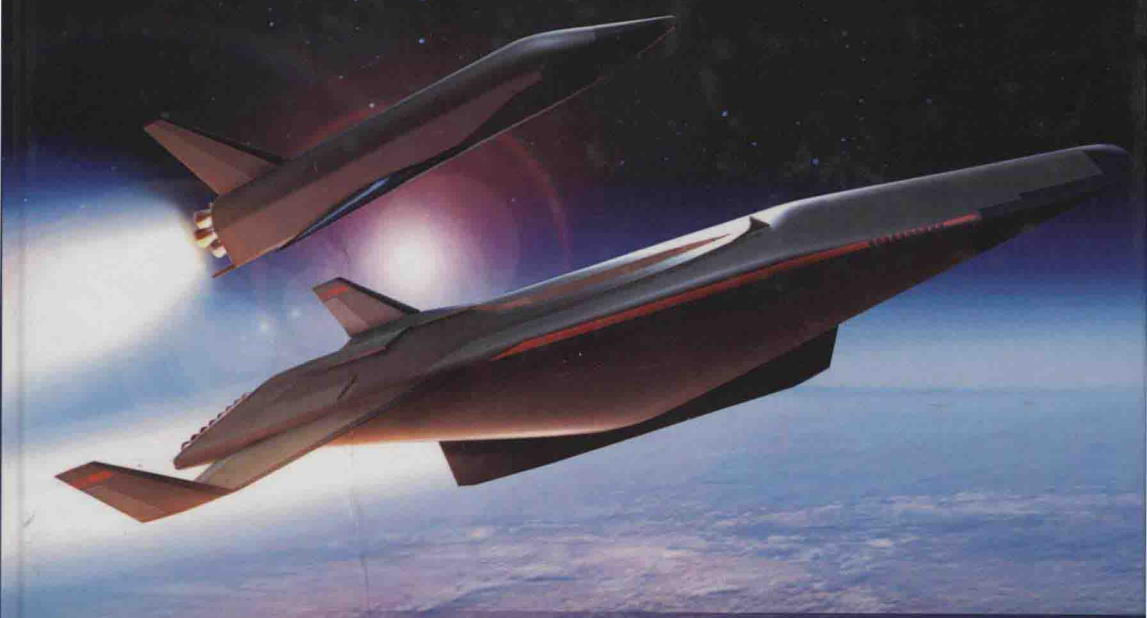
anced Nanomaterials for Aerospace Applications



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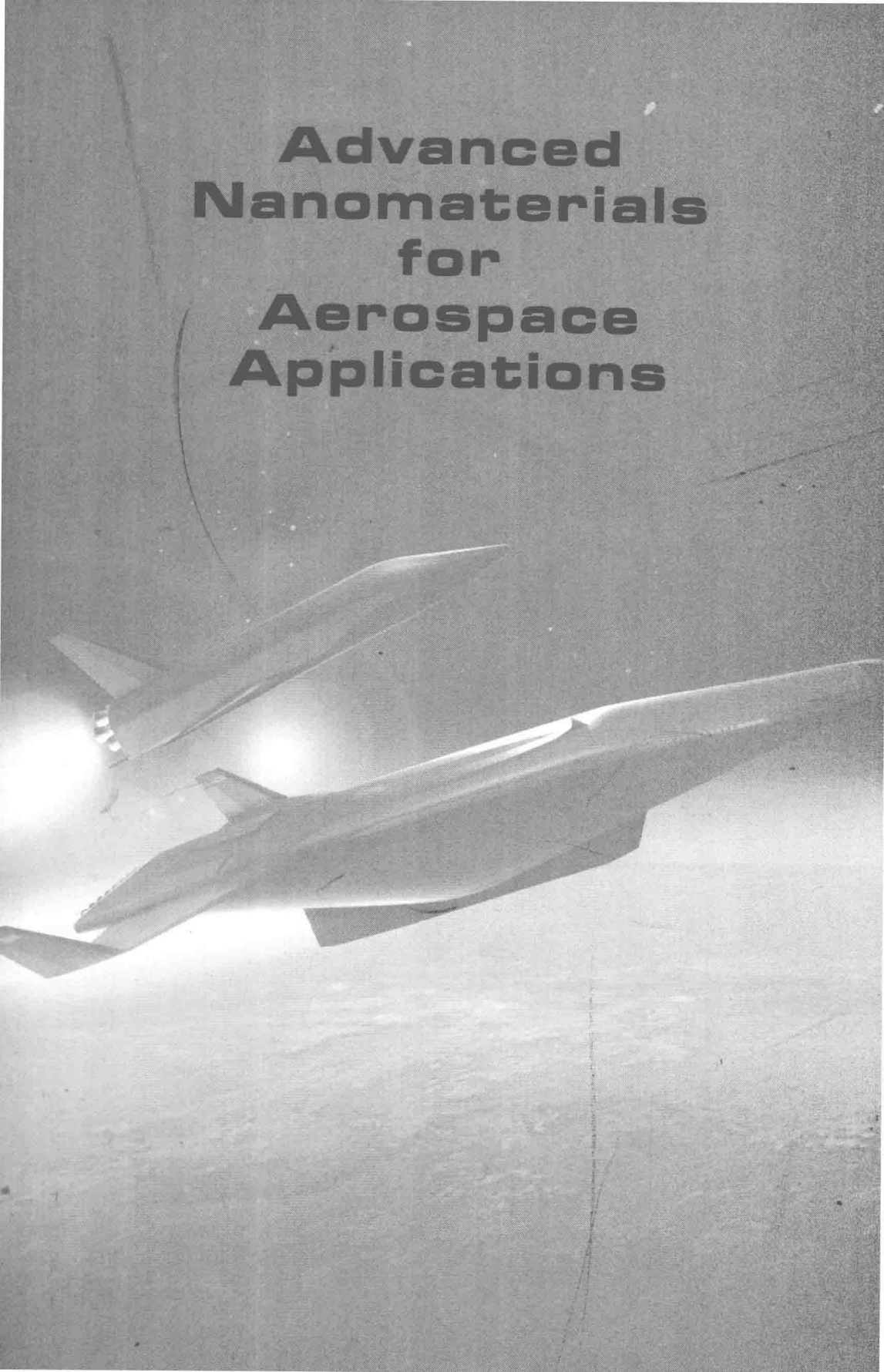

Preface

The book titled *Advanced Nanomaterials for Aerospace Applications* has been developed for a community interested in aerospace science and nanotechnology. Scientists and engineers of the NASA-University Research Center for Advanced Nanoscale Materials (CANM) at the University of Puerto Rico and from the NASA John H. Glenn and Ames Research Centers, the George C. Marshall Space Flight Center, the Jet Propulsion Laboratory, Pennsylvania State University, and INFN-Laboratori Nazionali di Frascati, Italy, have joined efforts to present the applications of nanomaterials in sensors, life support systems, regenerative fuel cells, Li-ion batteries, robust lightweight materials, nanoelectronics, and electromagnetic shielding.

The CANM at the University of Puerto Rico has been involved in the development of these exciting research areas in collaboration with NASA centers for more than 10 years. Most of the scientists and engineers who have been part of the CANM are authors or co-authors of the chapters in this Book. Their efforts and collaborations on the research, development, and applications of nanomaterials have advanced some of the technology to higher NASA Technology Readiness Levels. The outcome of some of these collaborations and interactions is summarized in the chapters of this book to be shared with the aerospace and nanotechnology communities.

Chapters 1 and 2 are devoted to sensor technology. Chapter 1 offers a thorough overview of a variety of sensors being developed in support of NASA's mission. Among these are sensors for leak detection, high-temperature physical state monitoring, emissions monitoring, fire and environmental detection, and radiation detection, among others. Chapter 2 focuses on the challenges associated with the fabrication and reproducibility of nanostructures into microsensors and microsensor systems. It also discusses the characterization of the basic properties of nanowires, and the

sensing mechanisms of nanostructures of different crystal structures. New sensor systems that can be enabled by nanotechnology are also discussed.

Chapters 3 and 4 present the use of nanomaterials for life support system applications. The chapters summarize the challenges faced by the environmental control and life support system engineers and scientists in improving the atmospheric revitalization and water reclamation subsystems currently used in space platforms such as the International Space Station. In this context, the chapters discuss the promising materials developments that may enable solutions to address these challenges for human space exploration missions beyond low earth orbit. These include water-recycling systems in space platforms and the effects of reduced gravity environment on the performance of life support systems (Chapter 4).

Chapter 5 discusses the performance advantages of different nanostructured electroactive materials, as compared to microstructured materials, for the negative electrodes (i.e., anodes) of lithium-ion batteries. Chapter 6 complements Chapter 5 by discussing the advances in the design of high-energy cathode materials for rechargeable lithium-ion batteries. Chapter 7 provides insights on the use of nanomaterials for renewable energy applications, in particular the development of nanomaterials used as catalysts for fuel cells and electrolyzers in regenerative fuel cell systems for NASA applications.

Chapters 8, 9, and 10 present other areas of nanotechnology relevant for aerospace applications. Chapter 8 addresses the use of nanotechnology for the development of nanoelectronic devices and applications. The chapter provides some examples of nanoelectronic devices and characterization techniques, as well as an assessment of the use of nanoelectronics in future NASA communication systems. Chapters 9 and 10 discuss the use of advanced nanomaterials for electromagnetic shielding, a topic of utmost relevance for long-duration human presence in space.

Since one of the roles of the CANM initiative was the development of approaches and mechanisms to foster nanotechnology outreach and education, it seems appropriate to include in this book a chapter on this most relevant subject matter. Accordingly, Chapter 11 discusses nanotechnology educational components based on advanced nanomaterials for aerospace applications and the

initiative implemented in this area as part of the CANM educational and outreach efforts.

Finally, Chapter 12 provides an overall NASA perspective on the future trends in nanotechnology and discusses initiatives and mechanisms currently in place to facilitate the advancement of research and technology development delineated by such trends.

There are many people and organizations that have made this book possible. In particular, the editors would like to thank each of the authors of the chapters featured in this book for their hard work and outstanding contributions. We wish to express our gratitude to the students, colleagues, and officers of the University of Puerto Rico, who in many ways contributed to the work featured in this book. We would like to extend our gratitude to Ms. Katrina Emery, former project director of the NASA University Research Centers Program, for her support and encouragement throughout the years. We are grateful to Ms. Kaprice L. Harris and Ms. Deborah A. Szczepinski (Stinger Ghaffarian Technologies, Inc.) of NASA Glenn Research Center's Office of the Chief Counsel, for their help regarding compliance with government regulations and policies.

It is our hope that this book will fill the expectations of the reader and presents an opportunity to learn more about advanced nanomaterials for aerospace applications.

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