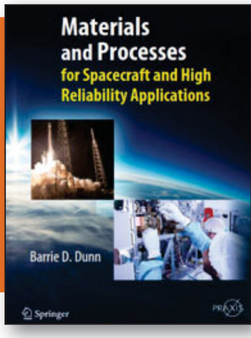


Materials and Processes for Spacecraft and High Reliability Applications

Barrie D. Dunn

Springer Praxis Books, 2016
667 pages, $229.00 (e-book $179.00)
ISBN 978-3-319-23361-1

As a materials scientist with some interest in space materials, reviewing this book was a delight. It is a follow-up to Dunn's 1997 book, *Metallurgical Assessment of Spacecraft Parts, Materials and Processes*. However, the current book updates the older one with the materials advances of the last 20 years, and is timely due to the steadily increasing number of spacecraft being launched with the increased demand for commercial telecommunication tools. Space is a punishing area in which to work, as the lightweight, robust materials must be able to withstand the shock and vibration of launch, and then remain functionally robust during exposure to cycles of excessive heat and cold while in a vacuum and exposed to the space radiation environment. Further, as Dunn notes, the materials in spacecraft can be exotic and doted upon, as the overall cost of materials in a spacecraft comprises only about 10% of the total program.

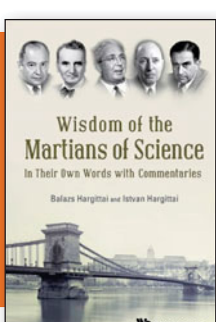
The book starts with a chapter describing the unique demands of spacecraft materials, and then is followed by a chapter on integration of materials into product assurance schemes. The latter chapter is a somber reminder to spacecraft researchers and engineers about the methodical approach that must be used to introduce new materials, and that a full team overviewing quality, reliability, and safety is needed to ensure proper functionality. From there, the book includes a chapter on how materials analysis can be used to prevent failure, and gives a top-level review of many of the materials processes that might be employed (welding, brazing, etc.), mixed with methods to control the processes and components. Another chapter discusses the metallography applied to spacecraft test failures, and another discusses electrical interconnections. The subject of whisker growth—something specific to the thermal cycles and vacuum environment endured by spacecraft—is also covered.

Corrosion prevention is another key topic, and useful advice and tables are provided regarding how to avoid joining metals of different potentials. The book concludes with a chapter on materials post-analysis, and then has 100 pages of tables on everything from linear expansion coefficients to examples of declared materials lists. The materials described are generally well known, such as standard polymers, titanium, and beryllium, as well as alloys of steel, aluminum, and copper. Graphene, which is now well researched by materials scientists, is portrayed as an emerging material for space. Dunn makes the reader appreciate how to join and use materials effectively so that they survive use on a spacecraft.

Readers should be aware that this book is primarily focused on spacecraft that would be used for commercial purposes, and includes only one sub-chapter for specifics required for manned compartments. There is neither mention of the requirements for oxygen cleaning nor the use of electrochemical fuel cells.

I strongly recommend Dunn's book as a resource for all working in spacecraft materials and assembly and other related fields. It provides a vast amount of information plus a consistent approach that would be hard to find in a web search. As emphasized throughout the book, there must be a team ready to examine all aspects of a material and how it will withstand the environment in which it will be used. Armed with Dunn's book, any materials researcher working on spacecraft will be off to a good start toward developing a reliable and high-performance vehicle.

Reviewer: Karen Swider Lyons *researches fuel-cell and battery materials and their integration into naval systems in Alexandria, Va., USA.*



Wisdom of the Martians of Science: In Their Own Words with Commentaries

Balazs Hargittai and István Hargittai

World Scientific, 2016
264 pages, $64.00
(softcover $34.00, e-book $27.00)
ISBN 978-981-4723

This is an uncommon book: It is neither a monograph nor a sum of five biographies, but rather a collection of quotations, commentaries, and ideas not only on basic and applied sciences, but also on politics, religion, life and human traits, environmental issues, and the future.

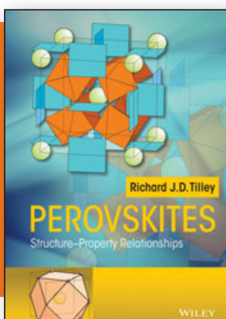
The book joins five prominent personalities (John von Neumann, Theodore von Kármán, Leo Szilard, Eugene P. Wigner, and Edward Teller) of the mid-20th century as Jewish-Hungarians in the fields of mathematics and computers, who completed higher education in Germany and as refugees emigrated from the anti-Semitic Horthy and Nazi regimes to America.

All five Martians became eminent players in fundamental sciences, but their wisdom remained open to top-level applications. For von Neumann, the axiomatization of set theory was as challenging as finding optimal conditions for blowing up high explosives. Von Kármán provided theoretical foundations for building bridges and also for constructing the best bomber aircraft. Wigner created the most elegant theories on the atomic nucleus and also directed engineers to build the world's first nuclear reactors. Szilard transferred his pioneering information theory to the concept of nuclear chain reaction and the critical mass. Teller was first a materials scientist, then a nuclear physicist, shifting his focus from fission to fusion.

All of them participated substantially to the discovery, design, and building of the atomic bomb. They were also deeply involved in politics, particularly during the Cold War, by strongly sustaining the need for weapons supremacy of the United States and being active members of the decision-making groups of the American security system. The Martians stressed that the time element was more crucial here than in fundamental research. They contributed to the recognition of science as a deciding factor on the national and international scene, thus leading to a massive increase of the influence of scientists in government and industry.

After World War II, the United States decided to keep nuclear science secret but to allow computer science to become public. According to von Neumann, this led to surprising results: "Nuclear matters remained classified, but espionage transmitted a great deal of vital information from this area to the Soviets, and the Soviet Union caught up soon with the United States. In contrast, there was less classification in computer science, yet the Soviet Union stayed behind eternally in this area." Von Neumann's observations are still confirmed today.

Reviewer: Aurelia Meghea *is Emeritus Professor at the University Politehnica of Bucharest, Romania.*



Perovskites: Structure–Property Relationships

Richard J.D. Tilley

Wiley, 2016
400 pages, $180.00 (e-book $144.99)
ISBN 978-1-118-93566-8

Perovskite is a mineral with formula $CaTiO_3$ and has given its name to a family of compounds that have a general formula ABX_3, where A and B are usually large cations, and medium-sized cation X is an anion. These compounds have a variety of physical and structural properties that lead to a plethora of applications. Recently, hybrid perovskites have also attracted attention due to their photovoltaic applications. Novel phenomena at artificial heterointerfaces have also become scientifically interesting. Hence, an up-to-date review of the literature in this area is needed and is the subject of this book, which is organized into nine chapters.

Chapter 1 deals with the description of the ABX_3 perovskite structure and the idealized composition: $SrTiO_3$. The possible variants such as cation displacement, Jahn–Teller distortion, and octahedral tilts are clearly explained and well illustrated with examples. Symmetry relationships and hybrid inorganic perovskites are also briefly addressed.

Chapter 2 describes related structures such as double perovskites, nitrides, and A-site-deficient and anion-deficient phases. In each case, the modifications of structure with respect to the ideal perovskite are simply explained, and many structures are nicely drawn with recent examples. Chapter 3 deals with hexagonal perovskites, where the structures have hexagonal instead of cubic close packing of AX_3 layers. The chapter lists several types of packing, including the $BaNiO_3$ hexagonal ideal structure. Chapter 4 presents modular structures. The first part is related to the description of various perovskite structures and gives well-known examples such as Ruddlesden–Popper or layered cuprate phases. The idealized structures are nicely drawn, and tables contain the crystallographic information.

The last five chapters concern the physical properties of perovskites. Chapter 5 focuses on the diffusion and ionic conductivity properties. After some mathematical definitions, the manipulation with defects of such properties is explained before introducing recent work on solid-oxide fuel cells. The dielectric and ferroelectric properties presented in chapter 6 are classical but are illustrated by recent results such as $BiFeO_3$ compounds or improper ferroelectricity. Chapter 7 discusses magnetic properties. Basic concepts are introduced, and typical behaviors (spin glass, control spins) are explained using recent examples. Discussions of multiferroic perovskites end this chapter.

Chapter 8 covers electronic conductivity. The chapter starts with the band-structure approach, and then discusses several concepts associated with electrical properties, such as semiconductors, the metal–insulator transition, high-T_c cuprates, half-metallicity, charge and orbital ordering, and magnetoresistance. Chapter 9 describes unique thermal and optical properties. Recent results such as the magnetocaloric effect of perovskite solar cells are introduced.

This book is clearly written and easy to read. Many recent references are included. The figures are useful and clear. It is written at an appropriate level for someone with a materials science background. I recommend this book to any research scientist or student in solid-state physics or materials science.

Reviewer: Wilfrid Prellier *of the Laboratory of Crystallography and Materials Science, ENSICAEN/CNRS/Normandie Université, France.*