

and basically strive for a de-emphasis of violence as a means for settling international conflicts. At the same time, they make their skills available to the military establishment as independent scientists, maintaining with merit that the objective analyses will lead to more rationality in the military arena. The military is well aware of the basic outlook of most JASONs but appreciates their talents and objectivity.

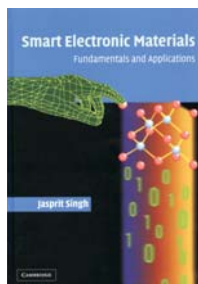
To demonstrate JASON's dilemma, Finkbeiner cites the well-known anecdote about three people, one of whom is a physicist, sentenced to death by guillotine. During the first two attempted executions, the blade gets stuck, and the two are freed. But the physicist takes a look at the guillotine and says, "I think I can tell you what's wrong with it." The correspondence to JASON's activities may not be too remote.

Today, independent scientific advice on national security has largely been eliminated in the top levels of government. Thus the independence of outsiders who operate on the inside, like the JASONs, is a unique asset today in the national security arena. This fact is duly noted and documented in Finkbeiner's very readable book.

Smart Electronic Materials Fundamentals and Applications

Jasprit Singh
Cambridge U. Press, New York,
2005. \$80.00 (408 pp.).
ISBN 0-521-85027-4

A day in the life of a fictitious salesman for a medical company introduces the topics discussed in Jasprit Singh's *Smart Electronic Materials: Fundamentals and Applications*. The author offers examples



of the diversity of "smart" materials currently employed in high-technology devices that are used daily by all of us without our spending a thought on the complexity and rich physics involved in understanding their

functions. The term smart has been used to describe materials—such as artificially made piezoelectric foams, ferroelectric polymers, and liquid crystals—that uniquely respond to an external stimulus, providing input–output decision capabilities and coupling the analog world to the digital world of information systems.

Smart materials can be found in all devices that are advancing information technology, with applications in electronics, optoelectronics, sensors and actuators, memories, and other areas (see the article by Siegfried Bauer, Reimund Gerhard-Multhaupt, and Gerhard M. Sessler, *PHYSICS TODAY*, February 2004, page 37). Yet we do not prepare graduate students in applied physics, materials science, and engineering to understand and fully explore the diversity of materials used, for example, in laptop computers, mobile phones, MP3 players, and similar popular high-technology items.

To illustrate the fascinating world of smart materials, Singh has chosen semiconductors, dielectrics, ferroelectrics, and ferromagnets. Intended for first-year graduate students, the book covers structural issues of crystalline and non-crystalline materials, including artificial structures, surfaces, and interfaces; electronic and transport properties; effects related to the polarization in ferroelectrics; optoelectrical effects; magnetic properties; and how these structures and properties are related to real-world applications. Many important materials and devices could not be included in the book because of limited space. For instance, Singh does not discuss flash memories, liquid crystals, and organic displays, all of which are extensively used in mobile electronic devices. The text, however, contains a wealth of information that can be used in graduate courses, such as the summary tables at the end of each chapter and the many illustrative figures.

Simple exercise problems are provided at the end of each chapter to familiarize students with the topics discussed and to give them a feel for the typical numbers involved. More challenging problems are not included in the text, but such an omission might have been Singh's intent in his introductory book. Obviously, in about 400 pages the author cannot cover in depth all aspects of smart materials. He uses space to discuss topics that can be found in most introductory physics books, information that might be useful to undergraduate students of engineering and materials science who have less knowledge of basic physics.

Smart Electronic Materials is a valuable guide for instructors who want to design their own courses on smart materials. Additional books on the subject can be used in conjunction with Singh's if students and instructors desire more depth and accuracy. Examples include *The Structure of Materials* (Wiley, 1999)

by Samuel M. Allen and Edwin L. Thomas, the second edition of *Physics of Semiconductor Devices* (Wiley, 1981) by Simon M. Sze, the reprinted version of the excellent textbook *Principles and Applications of Ferroelectrics and Related Materials* (Oxford U. Press, 2001) by Malcolm E. Lines and Alastair M. Glass, and *Fundamentals of Photonics* (Wiley, 1991) by Bahaa E. A. Saleh and Malvin C. Teich.

Smart Electronic Materials mostly succeeds in its aim of offering readers basic skills to understand properties of diverse materials relevant in today's information-technology-based society. The sometimes sloppy and even incorrect use of scientific terms—for example, Singh's use of photocurrent when he means pyroelectric current—does not detract significantly from the book's usefulness. The few inaccuracies in scientific content are also not too surprising: A single author cannot have profound expert knowledge in all the diverse fields of applied sciences covered in Singh's book.

Overall, I do not know of any other text that tries to cover such a wide range of topics. I would like to see a second, revised edition with more in-depth discussions of smart materials and with fewer topics that are already thoroughly discussed in standard texts on physics.

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J. Robert Oppenheimer A Life

Abraham Pais,
with supplemental material by
Robert P. Crease
Oxford U. Press, New York, 2006.
\$30.00 (353 pp.).
ISBN 0-19-516673-6

As one of the iconic scientists of the past turbulent century, J. Robert Oppenheimer (1904–67) has been a central character of books, conferences, plays, films, and even an opera, *Doctor Atomic*, which debuted in 2005. Naturally, several new biographies have appeared near Oppenheimer's centennial year. Robert P. Crease has completed and supplemented the unfinished biography *J. Robert Oppenheimer: A Life* by the

