

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.

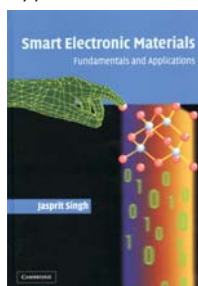
To demonstrate JASON's dilemma, Finkbeiner cites the well-known anecdote about three people, one of whom is a physicist, sentenced to death by guillotine. During the first two attempted executions, the blade gets stuck, and the two are freed. But the physicist takes a look at the guillotine and says, "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.

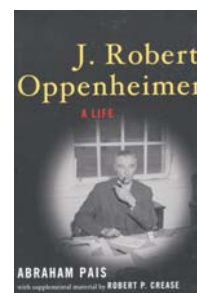
Overall, I do not know of any other text that tries to cover such a wide range of topics. I would like to see a second, revised edition with more in-depth discussions of smart materials and with fewer topics that are already thoroughly discussed in standard texts on physics.

Siegfried Bauer
Johannes Kepler University
Linz, Austria

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



late Abraham Pais. Crease's involvement came at the request of Pais's widow, Ida Nicolaisen, who supplied her husband's notes after he died in 2000. Before moving to Rockefeller University in New York in 1963, Pais had been a professor at the Institute for Advanced Study in Princeton, New Jersey, during most of the 17 years that Oppenheimer was its director.

Both Pais and Crease have written well-received books on the history of science. For the Oppenheimer biography, Crease tried to follow the intentions of Pais, as inferred from his notes, without appreciable reorganization, and he has added four excellent supplemental chapters. The result is what C. N. Yang has called "a kaleidoscopic approach to [Oppenheimer's] life, shedding insightful light on [his] personality and times."

Pais's book begins by describing Oppenheimer's life through the 1930s, a cursory account based largely on secondary sources and on Thomas S. Kuhn's 1963 interview with Oppenheimer. Crease tries to identify the secondary sources but doesn't always succeed. I noticed some paragraphs that appear unaltered from Pais's own autobiography, *A Tale of Two Continents: A Physicist's Life in a Turbulent World* (Princeton U. Press, 1997). The chapter on Oppenheimer as a teacher at the University of California, Berkeley, in the 1930s consists mainly of a quotation from the Kuhn interview and a longer one from Robert Serber, who went there as Oppenheimer's postdoctoral assistant. For this earlier period of Oppenheimer's life, I prefer one of the recent excellent biographies such as *J. Robert Oppenheimer and the American Century* (Pi Press, 2005) by David C. Cassidy or *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (Alfred A. Knopf, 2005) by Kai Bird and Martin J. Sherman.

Oppenheimer's life in the 1930s aside from his physics is told partly in his own words, taken from his published testimony before the 1954 Personnel Security Board (PSB) hearings that led to the removal of his security clearance. At those hearings he identified Jean Tatlock, with whom he had an affair while teaching at Berkeley, as the person who first introduced him to left-wing friends and to political issues he had ignored earlier. In the fall of 1940, Oppenheimer married Katherine ("Kitty") Puening, with whom he had two children. Tatlock later committed suicide in 1944.

Only five pages are devoted to the period between 1939 and 1945, from the

discovery of nuclear fission to the bombings of Hiroshima and Nagasaki. Yet nine pages of small type present the full text of Oppenheimer's farewell address at Los Alamos on 2 November 1945. Pais regarded the address as an important scientist's credo. It does not offer an optimistic view of the future of nuclear weapons or their effective control. Presented in Oppenheimer's lofty style, the speech seems dated and overly preachy.

Pais offers a full account of the Institute for Advanced Study's history, included Oppenheimer's directorship and the institute's conflicts and academic politics. He gives a rundown of Oppenheimer's role in important postwar physics conferences and includes vignettes of notable participants (some of whom were permanent residents of the institute). He also covers Oppenheimer's sometimes unfortunate interactions with them. Pais presents brief testimonials from well-known physicists regarding Oppenheimer's superb directorship over wartime Los Alamos. Such treatments in the book are examples of the kaleidoscopic approach that Yang refers to. Lengthy excerpts from Oppenheimer's many public lectures tend to be repetitive.

The remaining part of Pais's book, as distinct from Crease's supplemental material, deals with the politics of nuclear proliferation from the early postwar years until the start of Oppenheimer's fateful 1954 security hearing. Pais felt that Oppenheimer's major influence on public policy reached its zenith in 1946 in the Acheson-Lilienthal report, largely the work of Oppenheimer, which proposed that a new international agency be established to control nuclear weapons and promote the use of nuclear energy. Bernard Berenson was chosen to make the proposal to the United Nations, but it was doomed from the outset because of the mutual distrust between the West and the Soviet Union. After that episode, Oppenheimer became a hardliner on the Soviet Union—not a pacifist, as some have mentioned. Yet he preferred tactical nuclear-fission weapons to the hydrogen bomb, which would be useful only for destroying large cities. His position brought him into conflict with US Air Force officials who favored a strategy of massive retaliation. It also led to his downfall.

In the supplemental material, about one-quarter of the book, Crease gives a masterful account of the PSB hearings that began on 12 April 1954, demonstrating that they were largely show

trials whose purpose was to undermine Oppenheimer's prestige and diminish his political influence. Oppenheimer's consulting contract with the Atomic Energy Commission would, in any case, have terminated in June—and it need not have been renewed. Crease reports the reactions of various observers—scientists and others—to Oppenheimer's "trial," including post mortems on his testimony (which many felt was inadequate) and judgments on Oppenheimer as an emotionally charged, cultural symbol. He describes Oppenheimer's public life after the hearings as that of an "insider in exile." Crease's exceptionally clear, objective, and moving story will appeal to most readers.

Laurie M. Brown
Northwestern University
Evanston, Illinois

Fundamentals of Solar Astronomy

Arvind Bhatnagar and
William Livingston
World Scientific, Hackensack, NJ,
2005. \$58.00, \$32.00 paper
(445 pp.). ISBN 981-238-244-5,
ISBN 981-256-357-1 paper

Like most areas of astronomical research, the study of our Sun is now a multi-wavelength enterprise involving a diverse group of researchers with expertise in various instrumental, analytical, and theoretical techniques. With the public's excitement over dramatic satellite images from space, it is easy to forget that only a few decades ago the field was almost entirely dependent on ground-based observations in the visible part of the electromagnetic spectrum. Arvind Bhatnagar and William Livingston's *Fundamentals of Solar Astronomy* is a welcome reminder by two distinguished solar-optical astronomers of the important role that those ground-based observations have played and continue to play in solar research.

According to the preface and back cover, the book's purpose is to stimulate interest in studying and observing the Sun and to bridge the gap between books that provide elementary information about the Sun and advanced texts on solar astrophysics. The authors state that their book is primarily aimed at university students and amateur

