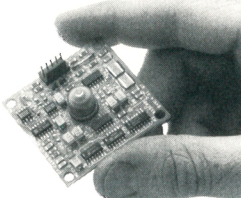


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flows that succinctly highlights their major features. And, somewhat unusual for a book addressed to this audience, there is a brief consideration of aerodynamic applications.

What one notices immediately upon opening the book is that it is filled with the mathematics of the subject, and there is scarce expository material between equations. Thus, the readers must themselves see the implications, applications and extensions of the material, or the instructor must supplement the text in these directions. If this is the price one must pay for comprehensiveness in a reasonably sized and priced text, the cost in this case may be justified. For what the text loses in terms of a more extensive exposition, it makes up for by providing, unencumbered, the mathematical basis of so much of fluid mechanics in condensed, easily grasped formulations. I found, using it as an instructor, that I would transcribe certain sections into my class notes hardly ever adding or subtracting a word or equation.

This new edition, published by a different publisher, has its own typography—and is over a hundred pages longer, in part because of some added text and topics and updated sections, but mostly because of a larger typeface. This text, like the earlier edition, is clearly not intended for an engineering audience; one would look in vain for much in the way of experimental data, useful engineering correlations, approximate methods or computational techniques. But for its intended audience and consistent with its title, it is an outstanding, comprehensive yet compact graduate-level text that merits a place on many a desk and bookshelf. I know of no other modern book in theoretical fluid dynamics that covers so much material so well.

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Functional and Smart Materials: Structural Evolution and Structure Analysis

▶ **Zhong Lin Wang**
and **Zhen Chuan Kang**
Plenum, New York, 1998. 514 pp.
\$125.00 hc ISBN 0-306-45651-6

Functional and smart materials have been intensively developed worldwide during the past 15 years, and their annual sales now reach close to \$100 million. The top three stars in the class are piezoelectric/electrostrictive ceramics, shape-memory alloys and magnetostrictors, all of which are

among the so-called mechanical solid-state actuators. Their major applications include positioners, motors and vibration suppressors.

For example, solid-state actuators allow the precision needed for manufacturing optical instruments such as lasers and cameras and the positioning accuracy for fabricating semiconductor chips to be of the order of 0.1 μm . Likewise, ultrasonic motors are superior to conventional electromagnetic motors for use in office or factory automation equipment, where they need to be smaller than 1 cm. The latter are not only larger but are rather difficult to produce with sufficient energy efficiency. The use of piezoelectric actuators for vibration suppression in space structures and military vehicles is also a promising technology.

When PHYSICS TODAY invited me to review Zhong Lin Wang and Zhen Chuan Kang's *Functional and Smart Materials*, I thought from the title that it would treat the properties of these materials and such smart structures as composite structures for smart skins and wings for space and underwater vehicles. Such a book would be more than timely. However, the actual content was totally different: It turned out to be a crystal chemistry book! Nonetheless, I found it interesting, and potentially useful.

Functional and Smart Materials is intended for readers who want to learn the fundamentals of atomic-scale crystal structure and the chemistry of inorganic materials—in particular functional and smart oxides. A large portion of the book is devoted to structural characterization using transmission electron microscopy, the authors' field of expertise. The book contains many micrographs and crystal illustrations of piezoelectric, electrostrictive and magnetostrictive materials. Although I am a device engineer, I, too, could appreciate the beautiful and artistic relationships of atomic arrangements in crystal lattices. Since the basic concepts of electron microscopy are completely covered in chapters 1 and 6, no prerequisite knowledge is required. An intriguing chapter ("From Structural Units to Materials Engineering via Soft Chemistry," chapter 5) discusses fabrication processes of nanoparticles and films from the viewpoint of soft chemistry. Thus, the book seems to be valuable for materials scientists involved in the characterization of smart materials.

I would suggest that the authors reconsider the following points for future editions: (1) Some of the basic concepts of smart materials are misleading as presented. For example, the statement "electrostrictive effect

means that the strain created is a linear or close-to-linear function of the externally applied electric field and stress" is not correct. Electrostriction is a nonlinear (quadratic) effect. (2) The book does not answer basic questions concerning the relationship between the crystal structure and its properties: Why does the perovskite preferably become ferroelectric? Why does the disordered ionic arrangement promote the dielectric relaxation? Why do carbon nanotubes store toxin species?

Some of these gaps may be bridged in part by reading in parallel other books describing materials design and properties, such as my two books, *Piezoelectric Actuators and Ultrasonic Motors* (Kluwer, 1996) and *Ferroelectric Devices* (Marcell Dekker, 1998), and *Shape Memory Materials* (Cambridge U. P., 1998) edited by Kazuhiro Otsuka.

In conclusion, I believe that this book is a unique, cutting-edge text on smart materials, and I recommend it as an adjunct to device design books used by engineers as well as scientists during the development of smart devices and structures.

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