science adviser to President John F. Kennedy. He also held various advisory positions under Presidents Dwight Eisenhower and Lyndon B. Johnson. Wiesner established many foreign communication channels and interacted with many world leaders while maintaining a lifelong interest in the arts. A dominant drive throughout his career was to steer the world toward more constructive military policies that emphasized arms control rather than the direct application of military power.

The memories and memoirs, edited by Wiesner's lifelong friend and associate Walter Rosenblith, are a collection of essays by many authors (including Wiesner) and so are almost impossible to summarize in a short review. In addition to the essays, the book contains a scholarly listing of Wiesner's contributions and key events in his life.

Wiesner's own writings about his life and work started in 1980 and continued throughout the decade until he suffered a stroke in 1989. His written work illustrates his informal, direct, and scholarly approach to complex issues. Wiesner's accounts in Rosenblith's book include an interesting essay on the rise and fall of the presidential science advisory system that peaked with the prominence of the President's Science Advisory Committee established by Eisenhower and declined thereafter until it ended when Richard Nixon abolished the committee.

Many of the book's essays are fascinating. One example is Spurgeon M. Keeny's account of his travels with Wiesner to Russia. Their goal was to search for the rumored highly sophisticated "cybernetic" methods for Soviet industry-wide production controls. Those methods turned out to be nonexistent. A second example is an essay by Anthony Lewis of *The New York Times* entitled "A Voice of Reason," which summarizes Wiesner's lifelong dedication to a nonescalatory foreign policy that emphasizes arms control.

The separate accounts by a number of Wiesner's professional associates—all of whom became close personal friends—present a recital of life at MIT during a critical period. Overall, the essays describe Wiesner as a cool but passionate leader in a variety of crucial contexts: student unrest, the struggle for racial and gender equality, and, repeatedly, efforts designed to redirect international conflict into controlled and peaceful patterns.

Several of the essays dealing with science advice to the government are of particular interest today in view of the extensive criticisms being voiced about governmental efforts to revise scientific findings to fit prescribed political outcomes. The issues are not new. The book relates how Nixon attempted to cut funding to MIT because his plans for the supersonic transport and for ballistic missile defense received adverse criticism from that institution. It also includes an account of how the Operations Research Society of America, a nongovernmental professional society, attempted to silence the critics of the antiballistic missile system by charging them with practicing operations research in an unprofessional manner.

After Wiesner's stroke, others, particularly MIT historian Philip N. Alexander, compiled further accounts of his life. *Jerry Wiesner: Scientist, Statesman, Humanist* was initially conceived by Rosenblith, and was completed by his wife Judy upon the editor's death in 2002. Above all, this collection of essays documents Wiesner's remarkable career. As is evident in the extensive material in the volume, it was a labor of love.

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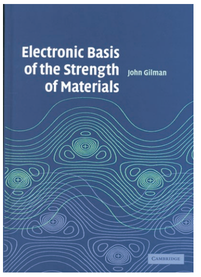
## Electronic Basis of the Strength of Materials

John Gilman
*Cambridge U. Press, New York, 2003. $95.00 (280 pp.).*
*ISBN 0-521-62005-8*

What underlying effects lead to the inherent strength of a solid? Can a material's response (elastic or plastic, for example, under applied stress) exhibit universal scaling behavior in terms of basic electronic quantities? Can such scaling behavior be explained from simple chemistry and physics principles?




Such questions have been under scrutiny for more than a century as cohesion and strength properties (really, a collection of properties) of materials have guided the development of several engineering disciplines and applications—whether structural (improved steels or turbine blades, for example) or microelectronic devices. Of course, the strength of a particular material, gleaned by science or alchemy, has been used for millennia without an understanding of its origin. Progress toward comprehending the strength of materials in terms of their microscopic mechanisms has been slow, in part, because the plastic deformation rate from small strains or shock loading varies by more than 30 orders of magnitude—just like electrical conductivity!

In *Electronic Basis of the Strength of Materials*, John Gilman addresses such issues by showing relationships between electronic structure of solids and ensuing mechanical properties. In most undergraduate textbooks on mechanical properties, the one example of a universal trend governed by bonding is, in fact, taken from Gilman's *Micromechanics of Flow in Solids* (McGraw-Hill, 1969). A log–log plot of the bulk modulus $B$, which quantifies a material's volume response to hydrostatic stress, versus the equilibrium atomic spacing $r_0$ yields a universal slope of $-4$ for ionic solids. The universal slope arises from the Coulomb potential's ($U \sim r^{-1}$) dominant effect on $B$ (defined as $-V_0[\partial^2U/\partial V^2]_0$, with $V_0 \sim r_0^3$). Remarkably, the same universal slope is also found for alkali metals and many tetrahedral covalently bonded crystals, as originally shown by Gilman in *Micromechanics of Flow in Solids*.

Now, after 40-plus years of studying the response of materials to applied stress, Gilman, in his new book, offers his unique perspective to provide simple, unifying concepts that connect a variety of observations. Electronic properties of particular relevance to strength are valence-charge density and electronic polarizability. Gilman, via simple arguments, shows such inherently quantum properties provide broad trends for elastic moduli (chapter 12), shear moduli (chapter 13), and dislocation mobility (chapter 18). But he also discusses other macroscopic responses driven by electronic effects, including chemical hardness in molecular systems (related to molecular-orbital gaps), ionization energy in nonmetals (related to band gaps), and plasmons in many other materials.

The plasmon picture is rarely discussed in Gilman's book but leads to observed trends, such as the linear relation with slope $-4$ found when plotting $\ln(B)$ versus $\ln(r_0)$; standard effective-mass arguments, in contrast, predict a slope of $-5$. There are other small jewels for the reader to explore, including the answer to the good preliminary-exam question, Why do simple metals form body-centered crystals instead of close-packed structures? Gilman provides brief historical perspectives and a plethora of important, original references—the kind of referencing often not done properly because of the use of internet search engines whose information reaches only to the predawn of the 1960s.

I would, however, be remiss not to discuss the book's shortcomings. For one, the publisher should have provided a biographical overview of the author to intimate to readers Gilman's professional qualifications. In addition, few recent references, except those of the author, are provided. Although typeset using LaTeX, the book's many equations are difficult to read. Improved editing is needed in several instances; for example, in chapter 4, elastic coefficients and ratios are introduced with terse descriptions that would benefit from a figure, but the figure does not appear until chapter 13. Also, the variable $\delta$ is used multiple times for different things. Oddly enough, the book just ends: No summary exists to tie discussions together. Finally, electronic-structure methods have recently addressed the strength of materials, such as ideal shear strength, and researchers are using those methods to help relate strength to structure defects and electronic properties, including changes in bonding topology. Because such issues are addressed in the book, it would have been worthwhile for Gilman to have made some connection to electronic-structure methods—especially because those methods will eventually affect mechanical modeling.

Because solids are, by nature, complex, Gilman offers a view that it is better to make approximations first—sometimes drastic ones—and provide simple calculations that are consistent with the rules of quantum mechanics and still yield properties in agreement with observation. In fact, Gilman uses only basic stress–strain relations, elasticity theory, Coulomb's law, the Heisenberg uncertainty principle, and simple quantum mechanics. All the concepts are presented in the initial eight chapters concisely (sometimes too much so) and with undergraduate-level mathematics. Hence the book should be accessible to advanced undergraduate students. Even so, I am dubious whether Gilman's book would, as the publisher claims, serve well as a supplementary text for teaching solid mechanics—that is, unless students have a good background in quantum mechanics and solid-state physics.

Nonetheless, whether intended for students trying to understand the basic origin of trends in strength of materials or for veteran researchers searching for a broader perspective, Gilman's book offers a one-of-a-kind contribution based on his lifetime of scholarship and his unique point of view. His contribution is our gain, and, for those interested in the field, *Electronic Basis of the Strength of Materials* is a worthy read.

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## Quantum Chromodynamics: High Energy Experiments and Theory

Günther Dissertori, Ian Knowles, and Michael Schmelling
*Oxford U. Press, New York, 2003. $120.00 (538 pp.). ISBN 0-19-850572-8*

Quantum chromodynamics is the widely accepted theory of the strong interactions that bind quarks into nucleons and nucleons into nuclei. Much like the standard model of electromagnetic and weak interactions, QCD is a quantum field theory (QFT) for massless vector particles whose