Fundamentals of Ceramic Powder Processing and Synthesis

T.A. Ring, (Academic Press, San Diego, 1996)
983 pages, $150.00, ISBN 0-12-588930-5

The term "processing" often carries different meanings depending on the context in which it is being used. Ceramic powder processing is generally held to involve four qualitatively distinct steps: raw materials preparation, forming/shaping, high-temperature processing, and finishing. Raw materials preparation involves both beneficiation of natural raw minerals and synthesis of novel powders. The details of the processes involved determine the chemical make-up and both the size and shape distributions of a given powder. All are important to the success of the process. The step that imparts the geometrical information (i.e., the desired shape) also determines the average and variance of many properties of the green microstructure (e.g., the green density of the powder compact and the coordination number of particles). High-temperature processing, or "firing," usually involves loss of some materials (organics and water), densification or sintering, and one or more chemical reactions including both solid-state and gas-solid reactions. Post-process finishing steps include machining (contrary to the common assertion, ceramics are readily and commonly machined using diamond-based abrasives), application of glazes or other coatings, or heat treatment to alter microstructure (via grain growth or change in phase distribution). Different texts that employ the term "ceramic processing" can have a very different emphasis.

Ring's book clearly emphasizes synthesis. This is a massive tome broken down into six sections. The second section, which is devoted to synthesis, is the largest, encompassing nearly one-third of the book. Considerably more than half of the book is occupied when the sections on characterization of powders and colloidal chemistry are added together with the section on synthesis. Forming, thermal processing (drying, binder burnout, and sintering), and finishing make up the minor fraction of the book. The title could be reversed to read "Synthesis of Ceramic Powders and Their Processing."

The construction and content of the book are both reminiscent of a college-level chemical engineering text. The author states that one goal of the text is to give a more formal and rigorous mathematical treatment than is customary in discussions of ceramic processing. It succeeds very well in meeting this goal. Potential readers should be aware that a working knowledge of partial differential equations is assumed. Exclusive of the first and last chapters, there is an average of 84 mathematical expressions per chapter, and three appendices are included on differential operators.

The book's strengths include the level of rigor in the analyses presented, the depth of coverage of synthesis and colloidal chemistry, and the up-to-date references. However, the expectations of the readers are high, and those without the benefit of a sound background in mathematics or outside help (such as a qualified instructor) will likely struggle to extract these benefits. Pleased with the content and presentation in this book, I have used it as the primary text for a graduate-level ceramic processing course, with success. I suspect, though, that the book works better in educating students with a chemical engineering background about ceramics than it does as a mainline ceramic engineering text competing with I.J. McColm and N.J. Clark's book, *Forming, Shaping, and Working of High Performance Ceramics* (Chapman & Hall, New York, 1986), or the widely used *Principles of Ceramic Processing*, by J.S. Reed (2nd ed., Wiley & Sons, New York, 1995).

Reviewer: *James D. Cawley received both his BS and PhD degrees in ceramic engineering. He taught on the faculty of the Ohio State University Ceramics Program for seven years before joining the faculty of Case Western Reserve University as the Great Lakes Professor for Ceramic Processing in 1991.*

Crystal Fire: The Birth of the Information Age

M. Riordan and L. Hoddeson
(W.W. Norton and Company, New York, 1997)
352 pages, $27.50, ISBN 0-393-04124-7

Here is by far the best book I have seen about the events that led to the invention, 50 years ago, of the transistor. It is, in essence, a combined biography of the three progenitors, John Bardeen, Walter Brattain, and William Shockley, their scientific insights and struggles, and their complex interaction with each other and with the other scientists and research managers who played crucial roles. The fourth object of this biographical *tour de force* is Bell Laboratories with its fierce manager, Mervin Kelly.

The first author, who holds appointments at two Californian universities, has degrees in physics and long experience of popularizing the field; the second is a historian of science, who holds appointments in both the department of history and that of physics at the University of Illinois and is renowned for her organizational and editing achievements for the International Project on the History of Solid-State Physics that led to the publication of a major historical overview, *Out of the Crystal Maze*. In the book here under review, Professor Hoddeson's expertise in combining archives, publications, and interviews is combined with Professor Riordan's expertise in physics and popularization.

Crystal Fire weaves together a sketch of the invasion of the United States by quantum theory and wave mechanics in the 1920s with the personal development of the three prime progenitors and the various precursors of work on diverse semiconductors that came together on that fateful day at Bell Labs in December 1947, and the further crucial improvement in the course of the next few years. There is a vivid account of the standoff between Bardeen and Shockley that led Bardeen to redirect his ultra-acute mind toward superconductors and impelled Shockley to his ill-fated industrial adventures (that nevertheless led him to found Silicon Valley). Altogether, the personalities of all the protagonists, major and minor, are depicted with the skills of experienced biographers, and one is drawn by degrees to a recognition of Shockley's character defects and shown how they drove him in the end to personal disaster, his Nobel Prize notwithstanding.

The origins of Texas Instruments and other companies, and the emergence of integrated circuits are also recorded in some detail, throughout with special attention to the reactions of the media.

Lest I leave the impression that this is only a biographical and sociological treatment, I want to emphasize that the stages of scientific confusion and progressive understanding; the technological leaps that led to single-crystal growth of germanium and silicon, to zone-refining and to progressive miniaturization; all these are presented with clarity and with scrupulous attention to sources and evidence. Frederick Seitz, to whom the book is dedicated, has asserted in *Nature* that "the historical research on which [the book] is based is impeccably sound, unlike many books of this kind." He calls the work "an enduring classic"—amen to that.

Reviewer: *Robert Cahn is a physical metallurgist turned materials scientist, currently attached in nominal retirement to Cambridge University. He has researched on intermetallics and many other metallurgical themes, has edited a number of journals and book series devoted to materials science, and has striven over the years to popularize materials science in the pages of* Nature. *He is a member of the Editorial Board of* MRS Bulletin. *This review originally appeared in* Contemporary Physics *39 (1998) p. 203, and is reprinted with permission of Taylor & Francis.*