BOOK REVIEWS

Ceramic Hardness

Reviewed by George D. Quinn, Ceramics Division, NIST, Gaithersburg, MD 20899.

REFERENCE: McColm, I. J., *Ceramic Hardness*, Plenum Press, New York, 1990, 324 pp.

This book was written with the aim of increasing the awareness of materials scientists, metallurgists, and engineers of recent developments in hardness testing of modern ceramics. Hardness is not a unique property, but is a response of the material to a specific indentor and test conditions. Several models of hardness are presented including simplified elastic or elastic plastic models, which set bounds upon the hardness limits. The sensitivity of hardness to crystallographic influences is well covered. The book covers the common test methods such as Mohs, Rockwell, Vickers, and Knoop, as well as less well known methods such as Berkovich and scratch hardness. Substantial progress has been made in recent years in utilization of microindentation methods to study fracture toughness, residual stress surface layers, and wear processes in ceramics.

The book is well structured and is a valuable contribution as a review of the state of the art, but there are some disappointments. The figures showing the Knoop and Vicker diamond indenters do not clearly define the facet angles. The author points out that hardnesses are very sensitive to test conditions, most notably microstructure, indentation size, and load. It is puzzling therefore that the extensive tables in the last chapter of the book fail to give the indentation load and further neglect to cite the original references to permit verification. The hardness precisions given are not plausible either. It is unfortunate that this book was written just before the completion of a comprehensive round-robin conducted by the National Physical Laboratory in the United Kingdom under the auspicies of VAMAS. That study highlighted serious experimental test methodology problems such as instrument calibration or operator bias which caused experimental errors of 10 to 20%.

Cracking associated with microindentations is usually to be avoided, since it interferes with the stress state under the indenter and affects the measurement accuracy. Recent developments have capitalized on the cracking, however, and a series of semi-empirical relationships have been derived which show that the extent of cracking can be used to measure fracture toughness. Unfortunately, although these relationships have some similarities, there are sufficient differences to cause a variation of over a factor of 2 in the values of fracture toughness. Rather than assess which of these equations is most suitable, McColm regrettably lists them all, thereby further confusing the reader. A variation on this methodology is to use the microindentation to produce intentionally controlled defects in test specimens. This is covered by McColm, but unfortunately Fig. 5.15 shows the wrong alignment for doing this.

Although the book is richly illustrated, it sorely misses photomicrographs of indentation damage zones and microcracking under an indenter such as those published by Hagan and Swain (*J. Phys. D.*, 1978, p. 2091) for glass.

The section on silicon nitride and silicon carbide is somewhat dated, since hot-isostatically pressed and pressureless sintered forms have largely supplanted hot-pressed and reaction bonded forms.

This book is valuable to materials scientists in part due to its excellent coverage of hardness-microstructure issues. Engineers would have appreciated more detail on test procedures, accuracy, and precision, and better tables of data. Indeed, the VAMAS round-robin conclusions cautioned strongly against using hardness as a material specification for advanced ceramics due to difficulties in obtaining consistent results.

Engineering Project Management

Reviewed by Everett C. Shuman, Registered Professional Engineer, State College, PA 16801.

REFERENCE: Blanchard, F. L., *Engineering Project Management*, Arabian American Oil Company, Dhahran, Saudi Arabia; Marcel Dekker, New York, 1989.

Engineering Project Management is part of a series on Cost Engineering. While the book is relatively short, 246 pages, the author has presented a wide range of details on many typical projects that are worthy of study by persons in managerial positions or who are inspired to become an effective manager. In a Preface, Blanchard gives reasons for the principles that are presented, but points out that there are so many ramifications in each project that answers to questions cannot be given like "recipes in a cookbook". Many terms are defined, including *project*.

A major item, although brief, is his Apology to all women because, when he wrote the book, he referred to managers only as men (e.g., in the chapter on selecting the project manager is a section on Picking the Man.

Each of the seven chapters starts with a Prologue that gives perspectives for the reader to consider and ends with a conclusion with a list of references. There are also footnote references when they apply to the text.

Many diagrams illustrate the interactions of the factors involved. Flow diagrams are used to indicate sequences in critical paths, construction timing to avoid delays, or engineering discipline in equipment design.

While Blanchard's experience has been many years in large corporate operations, he points out that the basic principles apply to any size project, no matter how small. Yet he also writes a chapter on megaprojects, those costing over 100 million and into the billions of dollars.

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Chapter 1 is unusual in referring to *corporate culture*. Blanchard contends that each corporation has a culture of its own. A table gives the items that can be evaluated. The author states: "Corporate culture is a composite reflection of the value set. This is established by the founders, and modified or reinforced by the company leaders who follow."

Planning in Chapter 2 is very complex because there are so many starting points for projects. The usual physical designs and facilities are often affected by environments and consideration of types of labor. In complex corporate structures, there may be internal competitive influences. There must be goals. A plan must have objectives with direction.

The Prologue of Chapter 3 states that organizations are dynamic, while organization charts are static. Proper organizations provide the composite of skills needed to accomplish the goals. All the facets of authority, responsibility, accountability, and delegation must be evaluated.

Chapter 4 on Staffing discusses selection of people. The problem is matching the person to the job. When people in the organization are not suited to a particular phase of the operation, an external contractor may be selected, either on a temporary basis or on a long-term contract.

When a project is underway, Chapter 5 says it "does not self-control." Obviously, projects that are overbudget or overschedule were not controlled. Controlling problems involves establishing where they took place so that all errors can be corrected. Controlling is a process, not lines on a chart. An essential element is feedback of results or a status evaluation to the makers of decisions. A process information diagram illustrates a way of handling communications between groups. A major phase of control is quality control. In addition to controls within the operating project, controls are needed over outside operations such as involve vendors, engineers, contractors, and consultants. Controls are also needed over safety, sanitation, health, and welfare.

In Chapter 6, the very large project called *megaproject* that is in the billion dollar range is described and its special problems outlined. A major consideration is local support. During planning, special interest groups must be identified, such as labor unions, small business groups, and environmentalists, as well as areas such as utilities, transportation, communications, and housing.

Since projects do not function as planned in many cases, Chapter 7 discusses Managing the Troubled Project. A well designed system will reveal changes that are early warnings of deviation from the desired results. A list of eleven items is presented for which documentation will aid in establishing the revised operation that eliminates poor results.

The book closes with an Appendix on Contractor Evaluation. The most important aspect of contractor performance is the competence of its personnel. Good project management is a team effort in which the team consists of all groups that have an influence on the production of the goals of the corporation or individual operation.

The reviewer questions the need for the book's high price, and feels that the book would help many people who are in lower income brackets or students in school.

Experimentation and Uncertainty Analysis for Engineers

Reviewed by Timothy L. Jacobs, Department of Civil and Environmental Engineering, Duke University, Durham, NC 27706.

REFERENCE: Coleman, H. W. and Steele, W. G., Jr., *Experimentation and Uncertainty Analysis for Engineers*, Wiley, New York, 1989, $44.95.

The stated objective of this book is to present "a logical approach to experimentation through the application of uncertainty analysis." The book is intended for upper level undergraduate and graduate courses and as a reference. Its examples and discussions are geared towards mechanical engineering problems and experiments. In addition, the book may be used as a reference for quantifying sources of error within an experimental process.

The book opens with a discussion of the sources of experimental error and the use of uncertainty analysis in assessing experimental error. This is followed by an introduction to statistical concepts and methodologies and a discussion of the measurement of uncertainty. In this section, the authors introduce the basic concepts of random variables, statistical distributions, sample mean and standard deviation, confidence intervals, and error estimation. The introduction of statistical concepts is not exhaustive and focuses on only those concepts most useful to experimental uncertainty analysis.

Following the introduction of basic statistical concepts and tools, the authors discuss the propagation of uncertainties, the application of general uncertainty analysis, and the use of uncertainty analysis in planning experiments. This section is very well written and is complemented by several illustrative and well documented examples. One attribute of this section is that each of the examples is presented and thoroughly explained in a meaningful manner to the reader.

The following three sections focus on the design of an experiment using detailed uncertainty analysis and the debugging and execution of an experiment. This book clearly distinguishes between bias errors and precision errors and provides illustrative examples of both. In addition, the authors discuss such topics as digital instrument errors and the dynamic response of instrument systems. Debugging and the execution of experiments are presented in the context of a heat transfer experiment with an emphasis on the replication of experimental results.

The final chapter presents a limited discussion of data analysis and the presentation of experimental results. Its main emphasis is on linear and multiple linear regression analysis. In addition, a brief description of standard errors in curve fitting is presented.

In general, this book is well written and easy to understand. The examples presented throughout the text are well documented and clearly illustrate the authors' point. Although the authors state that this book can be used as a text for upper level undergraduate and graduate classes of all engineering disciplines,