

BOOK REVIEW: MATERIALS SCIENCE AND ENGINEERING -AN INTRODUCTION

By William D. Callister

SIXTH EDITION, WILEY INTERNATIONAL, 2003.

For a number of decades, Materials Science and Engineering an Introduction, has been an essential and trusted source of literature, as an introduction to Materials Science and Engineering. Now revised and updated the sixth edition is now available.

This latest edition blends important traditional materials engineering subjects coupled with modern technologies, techniques and practices. The book's 820 pages contains information divided into chapters on Introduction, Atomic Structure and Inter-atomic Bonding, Structure of Crystalline Solids, Imperfection in Solids, Diffusion, Mechanical Properties of Metals, Dislocation and Strengthening Mechanisms, Failure, Phase Diagrams, Phase Transformations in Metals, Application and Processing of Metal Alloys, Structure and Properties of Ceramics, Application and Processing of Ceramics, Polymer Structures, Characterization Application and Processing of Polymers, Composites, Corrosion and Degradation of Materials, Electrical Properties, Thermal Properties, Magnetic Properties, Optical Properties, Economic Environmental and Social Issues in Materials Science and Engineering.

The first chapter provides a useful introduction to the student in terms of history, the importance of the subject, development of advanced materials and future trends. Many of the chapters that follow deal, with the fundamental aspects of Materials Engineering on the atomic, microscopic and macroscopic scale. The concept of electronic structure and the various types of bonding in solids is covered, along with the specification of planes and directions within the perfect crystal. In reality however crystals are not perfect so their defects are explained through the presence of vacancies and dislocations. These ideas are further developed and employed to explain the mechanical behavior of metals, how dislocations are involved in particular slip systems in given lattice types and the benefit of dislocations and grain boundaries in helping to increase the strengthen of metals and alloys. A macroscopic/microscopic examination is given on how to recognize ductile and brittle fracture and fracture due to fatigue. Adequately covered by the author is the value of understanding and interpreting a phase diagram with reference to the cooling of alloys under equilibrium conditions, the development of the microstructure and the determination of phase composition and amount of each phase. Coupled to this quenching and cooling in an isothermal environment is mentioned and how it leads to the formation of martensitic, bainitic and pearlitic microstructures, as well as the industrial cold

working and annealing of ferrous and non ferrous alloys. The hardening of material is detailed through diffusion and the applications of Fick's laws.

The information given on polymers considers the structure of polymer molecules, polymerization, mechanical behavior, fabrication and their processing. This leads well into the next section which looks at the way in which different materials previously studied can be combined to form composites such as metal matrix composite, polymer matrix composites, ceramic matrix composites, carbon carbon composites and hybrid composites. With the basic foundations now developed the next chapters talk about the degradation of the materials analyzed and their electrical, magnetic, optical and thermal properties. The degradation mainly involves the fundamental aspects of corrosion theory, the various types of corrosion, passivity, protection methods and high temperature oxidation.. Electrical properties are considered in terms of bonding and how materials such as silicon and germanium can be doped to make n and p type semiconductors. Electronic structure is again used to explain the magnetic aspects of material behavior.

Although the book possesses many examples as well as questions with answers, the sixth also includes a free CD-ROM, which plays a prominent role in appreciating, understanding and visualizing various concepts towards the understanding of material behavior. Although the book is packed with all the important diagrams and features the CD gives the reader the opportunity not only to browse the text but also to have a fair degree of computer interaction with the subject. Interactive play allows the student to grasp the main ideas related to directions and planes in a crystals, edge and screw dislocations, motion of dislocations, practical construction of stress/strain diagrams, phase diagrams, diffusion, geometry of polymers and structure of ceramics. The CD in addition to the book contains a myriad of data related to crystals, metals and alloys. Detailed solutions to selected problems are also provided in the CD. The design of the questions is extremely good as it requires the student to collect information needed to answer the question and analysis of diagrams.

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