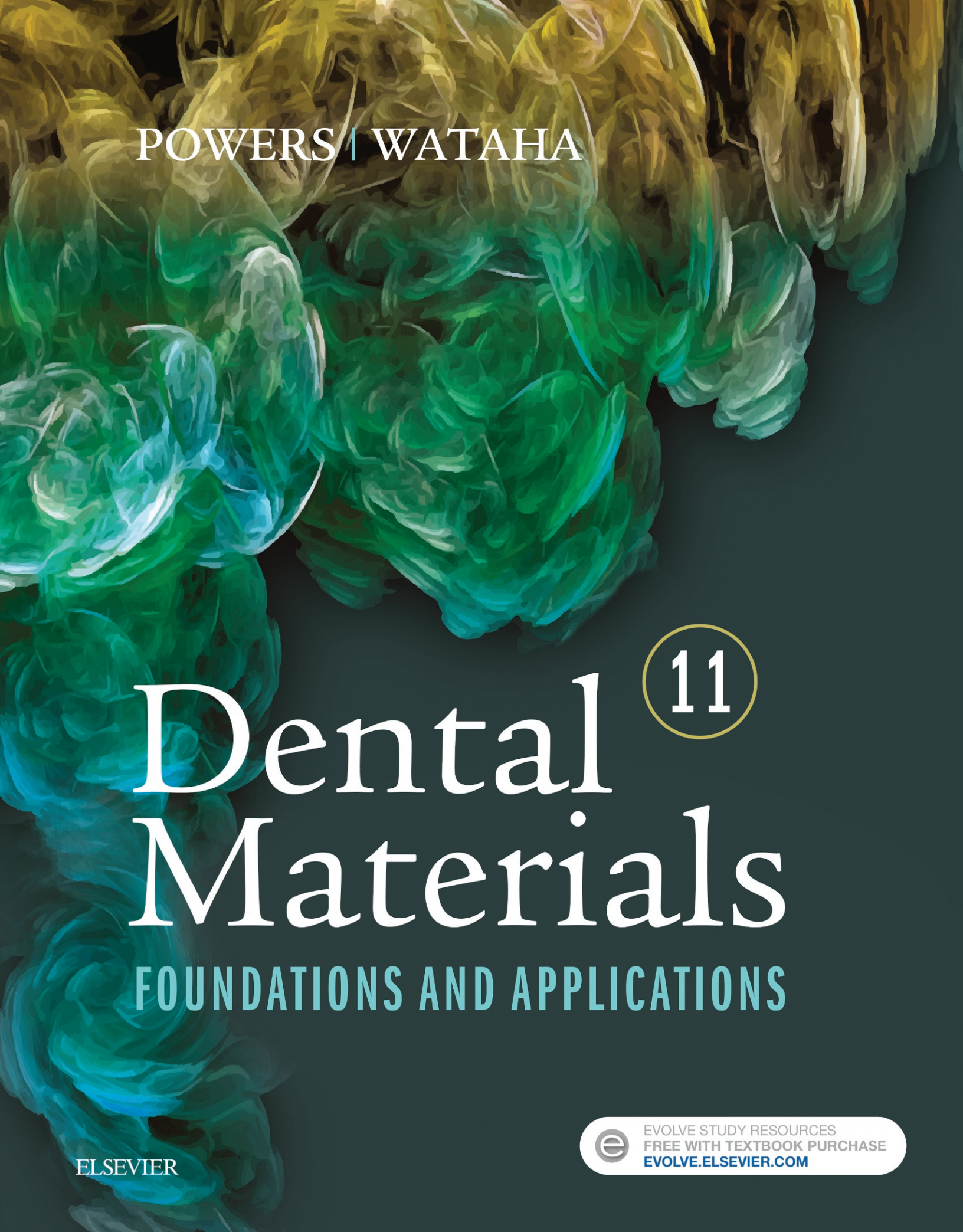
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Dental Materials
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Dental Materials 11

FOUNDATIONS AND APPLICATIONS

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PREFACE

Dental Materials: Foundations and Applications presents contemporary information about clinical and laboratory dental materials used throughout all dimensions of dental care.

BACKGROUND

Now in its eleventh edition, this textbook was edited for over 30 years until 2003 by Dr. Robert G. Craig. Dr. Craig contributed to the education of literally thousands of health profession students, using his research knowledge and inherent teaching skills to promote an understanding of dental materials. This text continues to honor Dr. Craig's commitment to the dissemination of accurate, current knowledge about dental materials in clinical practice. We continue to follow his philosophy of teaching students and clinicians the "hows & whys" of the materials they use to treat their patients.

AUDIENCE

This textbook is intended for students in dental, dental assisting, and dental hygiene programs. It also is an excellent resource for dental technology programs or programs training midlevel providers and will serve as a comprehensive, contemporary reference for any practicing dentist or dental professional. Finally, it is a good resource for those in need of a thorough review of dental materials for general or specialty board examinations.

ORGANIZATION

Our goal with *Dental Materials: Foundations and Applications,* 11th Edition, is to provide a comprehensive source of information about dental materials. Following a discussion of the nature of materials, the book provides an overview about how materials are used to treat or prevent disease and trauma. The book then covers important properties of materials, followed by all preventive and direct restorative materials used in contemporary dental practice. Later chapters focus on materials used to fabricate indirect restorations that are critically important to the restoration of a patient's oral health and are important to the dentist or dental professional because of the need to communicate expectations accurately to the patient or laboratory technician.

In this edition, all chapters have been revised, but chapters on ceramics, implants, impression materials, and polymers have been completely redone to present up-to-date information at an appropriate level. We have added over 60 new clinical photos to help students understand the applications of materials in dental practice and help teachers convey the same. We have added information throughout about the rapidly emerging area of "digital dentistry." We have also added an introductory section on the nature of materials to give readers a solid foundation to understand how different materials are, or are not, related.

Key terminology is set in bold type, critical statements are italicized, unusual words are defined in brief text boxes, and quick review or summary statements are placed at the ends of chapters or major sections. Finally, a glossary of terms is placed at the end of the textbook. In addition, a companion website created just for this book (http://evolve.elsevier.com/Powers/dentalmaterials) contains a variety of resources designed to enhance both education and study (see listing below).

KEY FEATURES

- *Comprehensive, Focused Coverage:* Fifteen chapters plus an introductory section present detailed information about dental materials used in the dental office and laboratory and all the materials relevant to day-to-day practice for dentists, dental hygienists, and dental assistants.
- *Cutting-Edge Content:* The latest materials used in dental practice are discussed, including those used in esthetic dentistry, digital dentistry, and preventive dentistry, and new advanced technologies in laboratory practice.
- *Art Program:* More than 500 full-color illustrations and photographs liberally supplement the text descriptions to help students learn to recognize the differences among the many types of dental materials and thoroughly comprehend their appropriate clinical manipulation. Dozens of intraoral photos show how materials are used, step-by-step, in many cases.
- *Consistent Presentation:* Each material presentation begins with a study of the properties and uses of that material before moving on to the specific manipulations and applications in dentistry, providing a logical framework for comparison among materials.
- *Review Questions:* Each chapter ends with 20 to 30 self-test questions, the answers to which are provided in the online instructor's materials, as a student study and assessment tool.
- *Quick Review Boxes:* Each chapter wraps up with a brief narrative summarizing the content to recap key concepts and help students assess their readiness to progress onto the next topic.
- *Note Boxes:* Interspersed throughout the text, these notes highlight key points and important terminology to help students build the foundational information necessary for clinical competence.
- *Summary Tables and Boxes:* Chapters summarize concepts and procedures within boxes and tables throughout the text for easy-to-read summaries of text discussions for reference and study.
- *Vocabulary Resources:* Bolded upon their initial text mention within the chapter, and defined in a back-of-book

glossary to help students master the language of dental materials.
- *Learning Objectives:* Each chapter begins with a detailed list of student outcomes that serve as study tools and checkpoints for student comprehension.
- *Supplemental Readings:* Chapters include listings of contemporary texts and journal articles that supply further information on the topic at hand to promote evidence-based practice and provide students with sources of in-depth study on specific topics.
- *Conversion Factors:* The inside back cover includes listings of common metric conversions as a handy reference for students.
- *Evolve Website:* A companion site provides resources to ease both instruction and learning.

NEW TO THIS EDITION

- *New Content:* Expanded and updated discussions are included for particularly dynamic areas such as esthetics, CAD/CAM technology, cements, ceramics, dental implants, and impressions (including digital impressions) to keep up with changes and advances in dental materials and associated technology.
- *Full Color:* This text is in full color, improving the clarity of images and helping students understand complex processes and sequences, and differentiate among the numerous types of dental materials, particularly.
- *New Artwork:* More than 70 new illustrations and photographs have been added, including images that show materials being mixed and used, making this often-difficult subject matter easier to grasp. Many intraoral photos are included to give the reader a sense of how the materials are used in sometimes complex sequences.
- *Appendices:* Several chapters include appendices that set apart from the text discussion and describe dental materials (e.g., agar impression material and zinc phosphate cement) that are less commonly used in modern dental practices.
- *New Ancillary Materials:* A color image collection, expanded test bank, and the addition of case studies are added to the instructor materials, whereas students benefit from access to instant-feedback assessment questions and interactive exercises to reinforce glossary terms.

COMPANION WEBSITE

An Evolve website has been created specifically for this text and is accessible via http://evolve.elsevier.com/Powers/dentalmaterials. Assets on this site include the following:

STUDENT RESOURCES

- Self-Assessment Practice Quizzes
- Instructional Videos
- Vocabulary Flashcards

INSTRUCTOR RESOURCES

- Test Bank (approximately 650 questions)
- Case Studies (including critical thinking questions)
- PowerPoint Presentations
- Image Collection
- Answers to Textbook Self-Test Questions
- Performance Skills Checklists

John M. Powers
John C. Wataha

Introduction: The Building Blocks of Restorative Dental Materials

OBJECTIVES

After reading this chapter, the student should be able to:

1. Describe the importance of the atomic number and the periodic table of the elements.
2. Compare and contrast ionic, covalent, and metallic bonds and their role in restorative dental materials.
3. Describe the differences between molecules and lattices and cite which restorative materials occur in which arrangement along with examples of materials using each arrangement.
4. List the four major classes of restorative dental materials and explain how each is unique and how the atomic structure of each leads to its macroscopic and clinical properties.

What makes up the materials in the world around us? What makes materials different from one another in color, strength, flexibility, conductivity, or weight? And why can we use some materials to restore teeth but not others? Why are some materials best suited for oral impressions, others for fillings, still others for implants? The answers to these questions are based on the way the most basic units of matter are arranged and interact. In the current preview, we will briefly explore the world of matter and materials as an introduction to restorative dental materials.

The oral environment is harsh and diverse, and the materials we use in that environment must survive many challenges. This environment experiences remarkable changes in temperature, substantial mechanical forces, adhesion of communities of microorganisms on every exposed surface, and chemical attacks from foods and from the body, with all these occurring over years to decades. Is it any wonder, then, that the materials needed to function in this environment are themselves diverse and complicated? Even more remarkable is that the roles we ask these materials to play. We have asked materials to act as surrogates for missing oral structures for thousands of years. But today, we increasingly ask materials to also serve as therapeutics or to adapt automatically to changing oral conditions.

The world of restorative dental materials is complex, exciting, and evolving. In this preview, we will introduce materials from the most basic perspective of the atom and explore how atoms interact to form the classes of materials we use every day in the treatment of oral disease. In the end, understanding these basic ideas is the key to understanding and predicting whether our everyday clinical treatments with dental materials will succeed or fail.

ATOMS: THE BUILDING BLOCKS OF DENTAL MATERIALS

The basic building block of all restorative dental materials is the **atom**. Atoms combine various ways via **bonding**; the bonding between atoms is a key feature of what makes dental materials behave the way they do. Beyond atom-to-atom bonding, atoms are arranged at a higher level into **molecules** or **crystals** that ultimately give dental materials their familiar clinical properties. It is these arrangements of atoms and the nature of the bonds among them that allows metals to conduct electricity, ceramics to have translucence, and elastomers to stretch. We will briefly discuss these ideas further in the following sections.

! ALERT

Atoms are the basic building block of all dental materials. The interactions between atoms are the key difference among materials.

Atoms

Every atom consists of a nucleus of protons and neutrons and **electrons** in cloudlike areas around the nucleus (Figure 0-1). The numbers of protons (the atomic number) determines the identity of the atom—whether it is copper, gold, or carbon, etc. We call atoms with different numbers of protons different **elements**. The components of atoms have a property known as charge: protons are positively charged, neutrons have no charge, and electrons are negatively charged. In their native state, all atoms have equal numbers of protons and electrons and therefore have no net charge.

The number of protons in the nucleus of an atom determines the number and arrangement of the electrons and electron clouds around it. These clouds are technically referred to as atomic orbitals; the complex shapes and properties of these orbitals are well beyond the focus of this chapter. For our purposes, it is sufficient to understand that these clouds of electrons are the basis by which atoms interact with each other and that electron numbers and properties are determined by the number of protons.

The atoms in our universe are arranged into a sophisticated table called the periodic table of the elements (Figure 0-2); this table is arranged in rows (periods) according