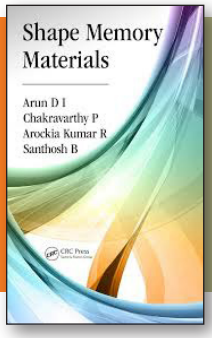

Shape Memory Materials

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This relatively compact book provides an overview of shape-memory materials at a level that is suitable for nonexperts, students, and researchers seeking to launch projects that use shape-memory materials, as well as experts who want to assess their activities within the broad field of shape-memory materials. Various classes of shape-memory materials are treated in a structured format that typically opens with a brief history, the underlying principles of the shape-memory effect, applications, and the challenges and/or benefits of that class of shape-memory materials. Each chapter concludes with references and a bibliography that cover both recent and historical advances in the field.

The book opens with an introduction to smart and stimuli-responsive materials, setting the stage for biomimetic function and the connection to shape-memory materials. Chapter 2 discusses shape-memory alloys (metals) and the elementary concepts of martensitic phase transformations, one-way and two-way effects, superelasticity, processing, and applications, including medical stents, prosthetic hands, and morphing aerospace components. Chapter 3 is a brief treatment of shape-memory ceramics, their underlying viscoelastic, martensitic, ferroelectric, and ferromagnetic mechanisms, and application to latching relays and other devices. Chapters 4 and 5 discuss shape-memory gels and shape-memory polymers, respectively. The chapter on shape-memory polymers is the most extensive in the book and covers the origins of one-way and two-way shape-memory effects, mechanisms for cross-linking and self-healing, mechanical analogues, and characterization techniques, including differential scanning calorimetry, thermomechanical analysis, and dynamic mechanical analysis.

Chapters 6 and 7 address shape-memory hybrids and shape-memory polymer composites. The latter chapter is more extensive and discusses mechanical, thermal, and electrical properties, processing, and applications such as sutures for wound closure, stents, and drug delivery. Chapter 8 provides an overview of high-temperature shape-memory metals, including the ranges of transformation temperatures that can be achieved in binary and ternary alloys, as well as an overview of thermosetting polymers for elevated temperature use. Chapter 9 covers electroactive shape-memory polymer composites that are stimulated by application of electrical current and Joule heating. The effect of various carbon-based fillers, including carbon nanotubes, is discussed. Chapter 10 offers an assessment of the future prospects of shape-memory materials, with a focus on shape-memory and electroactive polymers and 4D printing—the time-dependent processing of 3D objects.

Readers from a variety of engineering and science backgrounds should find the material easy to read. In most cases, the mechanisms for the shape-memory effect in each class of material are presented in a schematic format that emphasizes concepts rather than detailed crystallographic, physical, or chemical treatments. The book frequently compares the characteristics of different shape-memory materials to preserve a high-level view of the field. Chapters include extensive treatment of one or more specific materials and their applications to underscore the nature and capabilities within that class of shape-memory materials. An exception to the high-level view is the more extensive chapter on shape-memory polymers, which occupies approximately one-quarter of the book.

Overall, this book is useful for nonexperts who seek to use shape-memory materials, for students and researchers who want to launch projects involving shape-memory materials, and for experts studying a specific shape-memory material who wish to frame their activities and knowledge within the larger field and explore creative applications.

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