Silver Nanoparticles: From Silver Halide Photography to Plasmonics

Tadaaki Tani

Oxford University Press, 2015
240 pages, $110.00
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This book gives an overview of silver (Ag) and silver halide (AgX, X = Br, I) nanoparticles used in the field of photography and other applications. Topics include structure, synthesis, photophysics, catalysis, photovoltaics, and stability.

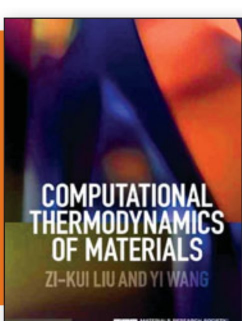
Chapter 1 introduces metal nanoparticles, plasmonics, and AgX photography. Chapter 2 reviews the shape and structure of metal, Ag, and AgX nanoparticles. The structures of nuclei and seeds, single-crystalline nanoparticles, nanoparticles modified by crystal defects, and composite structures are described. The chapter then gives methods for characterizing the crystal structures. Chapter 3 reviews the preparation of Ag nanoparticles and related materials for plasmonics and AgX photography. The chemistry of nanoparticle synthesis is given, including nuclei and seeds, preparation of single-crystalline nanoparticles, and growth of asymmetric nanoparticles through the introduction of defects and surfactants. The preparation of AgX nanoparticles for photography focuses on AgX-gelatin interactions and a discussion of various methods for preparation of single-crystalline and tabular AgX nanoparticles. There is a description of industrial-scale AgX nanoparticle synthesis. Methods for the arrangement of AgX and Ag nanoparticles needed for fine imaging and fabrication of photographic film are described.

Chapter 4 covers light absorption and scattering of Ag, including molecule-scale Ag nanoparticles as well as larger isotropic and anisotropic Au nanoparticles, nanorods, and nanoplates. There is a discussion of light absorption of J- and H-aggregated chromophores, Ag nanoparticles, and related materials in AgX photography. Chapter 5 discusses catalysis by Ag and other metal nanoparticles in plasmonics and photography. Topics discussed include photocatalytic water splitting and hydrogen production. There follows a discussion of the role of Ag catalysts in the mechanism of photographic development.

Chapter 6 focuses on the photovoltaic effect in Ag and other metal nanoparticles, covering light-induced charge separation in inorganic and organic semiconductors. The chapter also covers light-induced charge separation in Ag/AgX nanoparticle systems in relation to photography. Chapter 7 covers stability of Ag and other metal nanoparticles in AgX photography. There is an extensive discussion of the effect of gelatin on the electrochemical properties of Ag nanoparticles and the reasons why it performs better than other polymers. The chapter also discusses the electronic structure of Ag nanoparticles in gelatin layers in ambient atmosphere and stabilization of Ag and other metal nanoparticles in photographic materials and plasmonic devices.

Historically, Ag and AgX nanoparticles have played central roles in photography. Due to the rise of digital photography, knowledge of AgX photography risks being lost. This book is important because it gives an overview of this field drawn from the history of photography and how it can be applied to emerging technologies such as catalysis, photovoltaics, and plasmonics. The author has worked in the photography industry for nearly 50 years and has a deep knowledge that is reflected in this book. There are 566 references, including critical articles from the early history of AgX photography, and 168 figures. This book is a useful reference for researchers and graduate students interested in all aspects of plasmonics and metal nanoparticles.

***Reviewer: Thomas M. Cooper** of the Air Force Research Laboratory, USA.*



Computational Thermodynamics of Materials

Zi-Kui Liu and Yi Wang

Materials Research Society and Cambridge University Press, 2016
260 pages, $89.99 (e-book $72.00)
ISBN 9780521198967

In the interest of transparency, MRS is a co-publisher of this title. However, this review was requested and reviewed by an independent Book Review Board.

This authoritative volume introduces the reader to computational thermodynamics and the use of this approach to the design of material properties by tailoring the chemical composition. The text covers applications of this approach, introduces the relevant computational codes, and offers exercises at the end of each chapter.

The book has nine chapters and two appendices that provide background material on computer codes. Chapter 1 covers the first and second laws of thermodynamics, introduces the spinodal limit of stability, and presents the Gibbs–Duhem equation. Chapter 2 focuses on the Gibbs energy function. Starting with a homogeneous system with a single phase, the authors proceed to phases with variable compositions and polymer blends. The discussion includes the contributions of

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external electric and magnetic fields to the Gibbs energy. Chapter 3 deals with phase equilibria in heterogeneous systems, the Gibbs phase rule, and phase diagrams. Chapter 4 briefly covers experimental measurements of thermodynamic properties used as input for thermodynamic modeling by calculation of phase diagrams (CALPHAD).

Chapter 5 discusses the use of density functional theory to obtain thermochemical data and fill gaps where experimental data are missing. The chapter introduces the Vienna *ab initio* simulation package (VASP) for density functional theory and the YPHON code for phonon calculations. Chapter 6 introduces the modeling of Gibbs energy of phases using the CALPHAD method. Chapter 7 deals with chemical reactions and the Ellingham diagram for metal oxide systems, and presents the calculation of the maximum reaction rate from equilibrium thermodynamics. Chapter 8 is devoted to electrochemical reactions and Pourbaix diagrams with application examples. Chapter 9 concludes this volume with the application of a model of multiple microstates to Ce and Fe_3Pt. CALPHAD modeling is briefly discussed in the context of genomics of materials.

The book introduces basic thermodynamic concepts clearly and directs readers to appropriate references for advanced concepts and details of software implementation. The list of references is quite comprehensive. The authors make liberal use of diagrams to illustrate key concepts. The two appendices discuss software requirements and the file structure, and present templates for special quasi-random structures. There is also a link to download pre-compiled binary files of the YPHON code for Linux or Microsoft Windows systems. The exercises at the end of the chapters assume that the reader has access to VASP, which is not freeware. Readers without access to this code can work on a limited number of exercises. However, results from other first-principle codes can be organized in the YPHON format, as explained in the appendix. This book will serve as an excellent reference on computational thermodynamics, and the exercises provided at the end of each chapter make it valuable as a graduate level textbook.

***Reviewer: Ram Devanathan** is Acting Director of the Earth Systems Science Division, Pacific Northwest National Laboratory, USA.*

X-Ray Diffraction for Materials Research: From Fundamentals to Applications

Myeongkyu Lee

Apple Academic Press and CRC Press, 2016
302 pages, $159.95 (e-book $111.97)
ISBN 9781771882989

X-ray diffraction (XRD) is a powerful nondestructive characterization technique for determining the structure, phase, composition, and strain in materials. It is one of the most frequently employed methods for characterizing materials.

This book distinguishes itself from other books on this topic by its simplified treatment and its coverage of thin-film analysis. It largely minimizes the mathematics and is profusely illustrated, making it a good entry point for learning the basic principles of XRD. The common thin-film structures (random polycrystalline, textured) and their relationships with the substrate (strain, in-plane rotation) are defined and explained. This makes it valuable to researchers who study thin-film deposition. The book includes example problems to reinforce the concepts covered, plus problems that can be assigned as homework.

The background physics is presented first. Chapter 1 covers the properties of electromagnetic radiation, including wave-particle duality and the generation of x-rays. Chapter 2 describes crystal geometry, explaining the concept of a lattice and how Miller indices are assigned to planes and directions, reciprocal lattices, and crystal structures. The scope of this treatment is above that found in introductory materials science and engineering textbooks. The interaction of electromagnetic radiation with materials is discussed in chapter 3, including interference and diffraction. Many of these topics will be familiar to those who have taken college physics, but here they are described with an emphasis on their importance to XRD.

After establishing the basic physics, the book describes the conditions required for XRD to occur in chapter 4. Bragg's Law and the Laue equations are presented and explained. Electron diffraction and the Scherrer equation for estimating nanoparticle size are discussed. In chapter 5, the main factors controlling the intensity of diffracted x-rays are delineated. These include scattering by electrons and atoms and the specific arrangement of atoms, the material's unit cell.

Specific applications of XRD are covered in chapter 6 (thin films), chapter 7 (single crystals), and chapter 8 (powder diffraction). Rocking curves for assessing thin-film quality as well as grazing incidence XRD for enhancing the signal from the surface and diminishing signal from the substrate are introduced. The Laue method for determining the orientation of single crystals is described in detail. The procedure for identifying phases present and lattice constant values is recounted.

This book is a highly accessible introduction to XRD for materials research. It is written in concise and clear prose. The text creates a cohesive picture of XRD. After finishing this book, researchers will be able to understand the basics of many materials science and engineering research papers.

***Reviewer: J.H. Edgar** of the Department of Chemical Engineering, Kansas State University, USA.*