

1. Record Nr.	UNINA9910816044803321
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Titolo	4D electron microscopy : imaging in space and time // Ahmed H. Zewail, John M. Thomas
Pubbl/distr/stampa	London, : Imperial College Press Hackensack, NJ, : Distributed by World Scientific Pub., c2010
ISBN	1-282-75991-4 9786612759918 1-84816-391-6
Edizione	[1st ed.]
Descrizione fisica	1 online resource (360 p.)
Altri autori (Persone)	ThomasJ. M (John Meurig)
Disciplina	570.28/25
Soggetti	Electron microscopy Hyperspace Space and time Three-dimensional imaging
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Note generali	Description based upon print version of record.
Nota di bibliografia	Includes bibliographical references.
Nota di contenuto	Acknowledgements; Preface; Contents; 1. Historical Perspectives: From Camera Obscura to 4D Imaging; References; 2. Concepts of Coherence: Optics, Diffraction, and Imaging; 2.1 Coherence - A Simplified Prelude; 2.2 Optical Coherence and Decoherence; 2.3 Coherence in Diffraction; 2.3.1 Rayleigh criterion and resolution; 2.3.2 Diffraction from atoms and molecules; 2.4 Coherence and Diffraction in Crystallography; 2.5 Coherence in Imaging; 2.5.1 Basic concepts; 2.5.2 Coherence of the source, lateral and temporal; 2.5.3 Imaging in electron microscopy; 2.6 Instrumental Factors Limiting Coherence References 3. From 2D to 3D Structural Imaging: Salient Concepts; 3.1 2D and 3D Imaging; 3.2 Electron Crystallography: Combining Diffraction and Imaging; 3.3 High-Resolution Scanning Transmission Electron Microscopy; 3.3.1 Use of STEM for electron tomography of inorganic materials; 3.4 Biological and Other Organic Materials; 3.4.1 Macromolecular architecture visualized by cryo-electron tomography; 3.5 Electron-Energy-Loss Spectroscopy and Imaging by Energy-Filtered TEM; 3.5.1 Combined EELS and ET in cellular biology; 3.6 Electron

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4. Applications of 2D and 3D Imaging and Related Techniques 4.1 Introduction; 4.2 Real-Space Crystallography via HRTEM and HRSTEM; 4.2.1 Encapsulated nanocrystalline structures; 4.2.2 Nanocrystalline catalyst particles of platinum; 4.2.3 Microporous catalysts and molecular sieves; 4.2.4 Other zeolite structures; 4.2.5 Structures of complex catalytic oxides solved by HRSTEM; 4.2.6 The value of electron diffraction in solving 3D structures; 4.3 Electron Tomography; 4.4 Electron Holography; 4.5 Electron Crystallography; 4.5.1 Other complex inorganic structures; 4.5.2 Complex biological structures 4.6 Electron-Energy-Loss Spectroscopy and Imaging 4.7 Atomic Resolution in an Environmental TEM; 4.7.1 Atomic-scale electron microscopy at ambient pressure by exploiting the technology of microelectromechanical systems; References; 5. 4D Electron Imaging in Space and Time: Principles; 5.1 Atomic-Scale Resolution in Time; 5.1.1 Matter particle-wave duality; 5.1.2 Analogy with light; 5.1.3 Classical atoms: Wave packets; 5.1.4 Paradigm case study: Two atoms; 5.2 From Stop-Motion Photography to Ultrafast Imaging; 5.2.1 High-speed shutters; 5.2.2 Stroboscopy; 5.2.3 Ultrafast techniques 5.2.4 Ultrafast lasers 5.3 Single-Electron Imaging; 5.3.1 Coherence of ultrafast packets; 5.3.2 The double-slit experiment revisited; 5.3.3 Ultrafast versus fast imaging; 5.3.4 The velocity mismatch and attosecond regime; 5.4 4D Microscopy: Brightness, Coherence and Degeneracy; 5.4.1 Coherence volume and degeneracy; 5.4.2 Brightness and degeneracy; 5.4.3 Coherence and Contrast; 5.4.4 Contrast, dose, and resolution; Further Reading; References; 6. 4D Ultrafast Electron Imaging: Developments and Applications; 6.1 Developments at Caltech - A Brief History; 6.2 Instruments and Techniques 6.3 Structure, Morphology, and Mechanics

Sommario/riassunto

The modern electron microscope, as a result of recent revolutionary developments and many evolutionary ones, now yields a wealth of quantitative knowledge pertaining to structure, dynamics, and function barely matched by any other single scientific instrument. It is also poised to contribute much new spatially-resolved and time-resolved insights of central importance in the exploration of most aspects of condensed matter, ranging from the physical to the biological sciences. Whereas in all conventional EM methods, imaging, diffraction, and chemical analyses have been conducted in a static -
