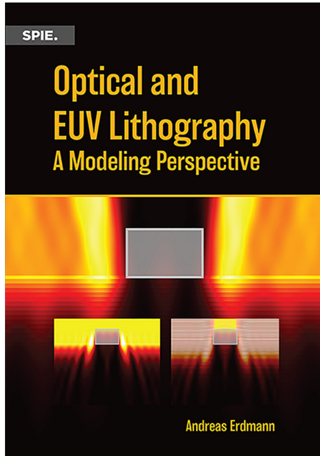
Book Review

Optical and EUV Lithography: A Modeling Perspective



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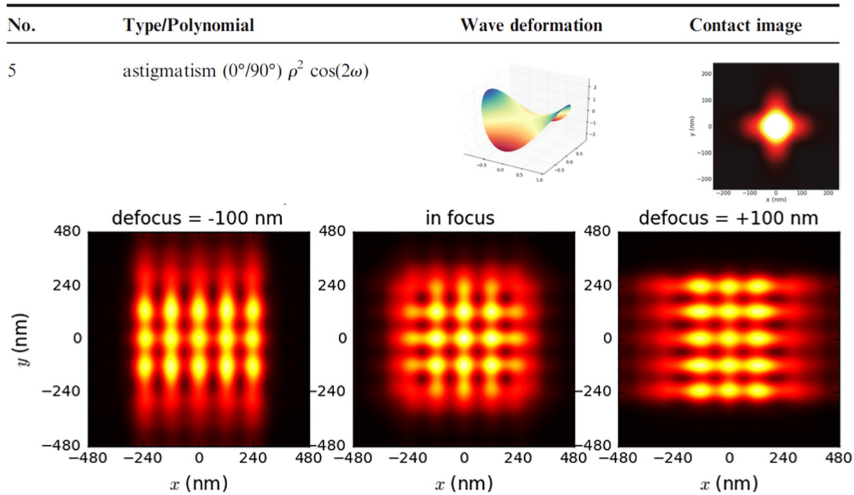
The fabrication of nanostructures on modern semiconductor chips using photolithography involves complex equipment and intricate processes. Highly accurate physical models and simulation techniques are necessary to research semiconductor lithography, to design and optimize the associated manufacturing technologies, and to construct reticles capable of imaging near atomic scales. With his stimulating modern textbook, *Optical and EUV Lithography: A Modeling Perspective*, Andreas Erdmann provides a handbook that aids anyone interacting with photolithography modeling and simulation in the understanding of complex modeling paradigms. This work is indispensable for researchers in photolithography modeling fields due to the wealth of succinctly and precisely presented information. It is also essential for the lithographers and Reticle Enhancement Technology and Correction Engineers working alongside modelers, as the author clearly explains lithography modeling concepts, making them accessible to all lithographers. The book is written in one voice by Dr. Erdmann based on his experience teaching at the Friedrich–Alexander University Erlangen–Nuremberg with significant input from the lithography modeling community.

The ten-chapter book commences with a history of photolithography and an explanation of basic concepts in the field. This is an important section that enables scientists new to the discipline to understand the building-block concepts that are frequently neglected or assumed by many texts. The second chapter describes the mathematical modeling of projection optics systems used in photolithography with math, graphs, and figures. Chapter 3 is dedicated to photoresist modeling techniques for multiple standard-resist systems.

In Chapter 4, Dr. Erdmann discusses optical resolution enhancements. This chapter explains off-axis illumination mathematically, textually, and in figures to help readers grasp not only the fact that off-axis illumination aids contact arrays, but how the aid is applied and the fundamental principles governing the aid. This an excellent example of the many thorough and clear explanations Dr. Erdmann delivers throughout the text. Chapter 5 follows with material-based resolution enhancements.

Extreme-ultraviolet lithography is discussed in Chapter 6, which explains modeling differences compared to deep ultraviolet (DUV) due to the reflective optics as well as the specifics and nuances associated with extreme ultraviolet (EUV) light. Chapter 7 discusses lithography technologies other than projection lithography, including proximity and interference printing.



No.	Type/Polynomial	Wave deformation	Contact image
5	astigmatism (0°/90°) ρ^2 cos(2ω)		

Chapter 8 covers the advanced topics of flare, polarization, and aberration modeling. It presents the Zernike set for describing aberrations in a clear and useful manner. The author first explains each of the first 11 Zernikes mathematically and as a plot, and its impulse response to a contact in a table. After the table, each of the Zernike sets is simulated in a contact array and explained in the text. This detailed explanation enables the reader to understand the full potential of the set from a few text pages. This is an outstanding example of the way Dr. Erdmann makes a complex topic accessible to the reader.

In Chapter 9, simulation techniques and mask and wafer topography are discussed. The waveguide and FDTD simulation methodology presentations are extremely clear, and it is especially useful that both methodologies are included in one handbook. Chapter 10 completes the text with a discussion of stochastics and modeling in a stochastic environment.

Anyone in the photolithography field will find Andreas Erdmann's *Optical and EUV Lithography: A Modeling Perspective* an outstanding addition to their library. It is a useful reference for all lithographic analytical and simulation needs in photolithography.

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