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Panagiotis D. Christofides, Antonios Armaou,  
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## Control and Optimization of Multiscale Process Systems

Interest in the control and optimization of multiscale process systems has been triggered by the need to achieve tight feedback control and optimal operation of complex processes, such as deposition and sputtering of thin films in semiconductor manufacturing, which are characterized by highly coupled macroscopic and microscopic phenomena. Drawing from recent advances in the dynamics and control of distributed parameter processes for which continuum laws are applicable as well as stochastic modeling of phenomena at mesoscopic/microscopic length scales, control and optimization of multiscale process systems has evolved into a very active research area of systems and control engineering.

This book—the first of its kind—presents general methods for feedback controller synthesis and optimization of multiscale systems, illustrating their application to thin-film growth, sputtering processes, and catalytic systems of industrial interest. Beginning with an introduction to general issues on control and optimization of multiscale systems and a review of previous work in this area, the book discusses detailed modeling approaches for multiscale processes with emphasis on the theory and implementation of kinetic Monte Carlo simulation, methods for feedback control using kinetic Monte Carlo models, stochastic model construction and parameter estimation, predictive and covariance control using stochastic partial differential equation models, and both steady-state and dynamic optimization algorithms that efficiently address coupled macroscopic and microscopic objectives.

Key features of the work:

- Demonstrates the advantages of the methods presented for control and optimization through extensive simulations.
- Includes new techniques for feedback controller design and optimization of multiscale process systems that are not included in other books.
- Illustrates the application of controller design and optimization methods to complex multiscale processes of industrial interest.
- Contains a rich collection of new research topics and references to significant recent work.

The book requires basic knowledge of differential equations, probability theory, and control theory, and is intended for researchers, graduate students, and process control engineers. Throughout the book, practical implementation issues are addressed to help researchers and engineers understand the development and application of the methods presented in greater depth.

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