



# Multiscale Methods: Bridging the Scales in Science and Engineering

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## Multiscale Methods: Bridging the Scales in Science and Engineering

Small scale features and processes occurring at a nanometer and femtoseconds scales have a profound impact on what happens at a larger scale and over extensive period of time. The primary objective of this volume is to reflect the-state-of-the art in multiscale mathematics, modeling and simulations and to address the following barriers: What is the information that needs to be transferred from one model or scale to another and what physical principles must be satisfied during the transfer of information? What are the optimal ways to achieve such transfer of information? How to quantify variability of physical parameters at multiple scales and how to account for it to ensure design robustness?

Various multiscale approaches in space and time presented in this Volume are grouped into two main categories: information-passing and concurrent. In the concurrent approaches, various scales are simultaneously resolved, whereas in the information-passing methods, the fine scale is modeled and its gross response is infused into the continuum scale. The issue of reliability of multiscale modeling and simulation tools is discussed in several, which focus on hierarchy of multiscale models and a posterior model error estimation including uncertainty quantification. Component software that can be effectively combined to address a wide range of multiscale simulations is described as well. Applications range from advanced materials, to nanoelectromechanical systems (NEMS), to biological systems, and nanoporous catalysts where physical phenomena operate across 12 orders of magnitude in time scales and 10 orders of magnitude in spatial scales. A valuable reference book for scientists, engineers and graduate students practicing in traditional engineering and science disciplines as well as in emerging fields of nanotechnology, biotechnology, microelectronics and energy.

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