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Preface

Structure Formation and Evolution in Soft Matter/Complex Fluid Systems

This special issue includes a collection of invited papers presented at the workshop on Structure Formation and Evolution in Soft Matter/Complex Fluid Systems held at the newly inaugurated Beijing International Center for Mathematical Research (BICMR), Beijing, China, from December 3 to December 7, 2007. The workshop was one of a series of workshops sponsored by BICMR in the yearlong thematic program on mathematical analysis, multiscale modeling and computations of soft matter/complex fluid systems.

The purpose of this workshop is for the participants to showcase their state-of-the-art research results, to learn the latest development and discuss future research in the area of multiscale modeling and simulation for the complex matter system. It is expected that the workshop will be able to promote the exciting frontier research and to stimulate scientific interest the challenging field across multiple disciplines.

Complex Fluids or Soft Matter is a class of materials whose properties are dominated by their microstructural features including molecular conformations as well as configurations and interactions among the microstructural components. These materials can form mesoscopic structures which ultimately determine the macroscopic property. Typical complex fluids include polymer solutions and melts, colloidal suspensions, foams, emulsions, liquid crystals, and most biological materials. In the past, studies on these materials were done primarily by researchers in the field of chemistry, chemical engineering, materials science and biochemistry. Since the early 1990's, soft matter has received increased attention from physics and applied mathematics communities. The primary goals of soft matter research are (1) to understand how fundamental physical laws coupled with the configurational features of the microstructure can lead to the formation of the mesoscale structures and thereby impact on the material's macroscopic properties, (2) to use the insight gained through modeling and simulation of the complex system to guide the development and design of novel functional materials.

Most soft matter systems consist of true multiscale material systems, in which the length scales range from nanometers to microns while the corresponding time scales of various dynamical processes can span from femtoseconds to seconds, or even hours for large scale ordering processes such as phase separation in polymer blends. Apparently, there could not be a single model or simulation algorithm that can be applied to such a system with such a wide range of length and time scales. Therefore, one of the important issues in studying dynamics in the soft matter systems is how to faithfully predict macroscopic material properties and behavior rooted in fundamental molecular processes through multiscale modeling and simulation, which consists of a suite of analytical

and/or computational models and inter-scale protocols bridging the various length and time scales.

One of the successful examples in multiscale modeling is the micro-macro multiscale method for complex fluids that couples the mesoscopic scale with the macroscopic scale of a typical continuum. The multiscale technique allows the direct use of kinetic models and thus avoid potentially inexact closure approximations. This advantage is obviously shadowed by increased demands in computing resources compared to the conventional continuum simulations of a single scale models. We anticipate that the evergrowing computing power and the development of more efficient algorithms will gradually offset the increased computational demand in multiscale simulations so that we will be able to simulate more complex material systems and, eventually, important industrial processing flows in the near future. Multiscale modeling in polymeric fluids is a very active and rapidly growing research area. We expect this field will continue to move forward at an accelerated pace in light of the advances already attained in multiscale analysis and simulations.

All papers in this special issue were peer-reviewed following the journal's established review process. We would like to take this opportunity to thank all the referees for their diligent work and wholehearted support.

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