

Soft and Biological Matter

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Frontiers and Progress of Current Soft Matter Research

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Preface

The soft matter research started more than one hundred years ago. Over a century, the correlated subjects have been examined extensively. People not only keep updating many new soft matter systems, and renewing the knowledge, but also looking into the new applications arising from new demands across areas of physics, biology and chemistry.

The systems of soft matter share some common characteristics, such as notable thermal fluctuations, multiple metastable states, mesoscopic multi-scale self-assembled structures, entropy-driven order-disorder transitions, macro flexibility. Briefly, these are the systems having “small stimulus, big response” and displaying strong nonlinearities. These characteristics are not so much related to their microstructures (at atomic or molecular levels) but more to their mesoscopic self-assembled structures. These obviously belong to multi-scale complex systems and certainly are good subjects for complex statistic physics research.

Within the different types of soft matter systems, flexible materials have been listed as one of the most important materials in recent years, due to the broad applications to big health and related area. In combination with big data and Ai technologies, flexible materials and the correlated flexible electronics will reshape our living and working styles. In this regard, the research efforts on soft materials are targeting on three main aspects, namely recoverable, multi-functional and biocompatible. The current major attention from the community is then focused on the identification and fabrication of new materials with high performance for use in protonic/electronic devices, environment friendly intelligent building materials with the applications in chemo-catalysis, drug delivery, gene delivery, biological imaging and tissue engineering. remote diagnosis related-fields. In particular, wearable, implantable, bio-degradable/absorbable and injectable flexible devices will exert a huge impact on human health and daily life.

This book is based on the lectures delivered by international experts in the 2019 International Graduate Summer School on Soft Matter and Non-equilibrium Physics. The school covers some fundamental aspects and frontier in non-equilibrium physics and soft matter research. Apart from the basic knowledge on nonlinear statistic physics, dynamics, computer simulations, and main

approaches and emerging systems in soft matter research, the particular attention is also devoted to new conceptual flexible functional materials, i.e. silk meso-molecular materials, molecular gels, liquid crystals, and the enriching areas, i.e. flexible electronics, new types of catalysis, etc. One of the intentions of this book is to start with the structure formation dynamics and the correlation between the structures and macroscopic performance. This lays down the foundation for the mesoscopic materials design and functionalization.

The book evolves from the lecturing style of the school. Therefore, the basic principles and technologies of computer simulations and experimental methods are explained in more detail. Illustrations, tables and videos are included in this textbook to improve the readability. Examples are added to help understanding. It can, therefore, be adopted as a reference book for senior undergraduate students, graduate students, and researchers who are interested in soft matter researches.

I am sincerely indebted to the authors for the great efforts in the composition of the respective chapters that combine timely and comprehensive reviews of current frontiers with the fundamental principles to serve the purpose of this book. My appreciation also extends to Dr. Q. L. Huang from Physics, the Xiamen University for her great effort and kind assistance in soliciting the manuscripts from authors, Dr. M. C. Huang and the whole editorial team of *Springer Nature* for their professionalism throughout the whole editing process. Finally, it is our sincere wish that this book will further stimulate exciting multilateral collaborations among the international scientific communities.



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Xiang-Yang Liu
State Distinguished Professor

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