

Nanomachines

The control of motion on the molecular scale is of fundamental importance for living organisms, and is one of the most fascinating challenges in nanoscience. The development of man-made nanoscale machines and motors and their exploitation to perform useful functions is one of the primary goals of nanotechnology. Scientists working in this area have been addressing fundamental issues at very small length scales, related to the motion of objects, the conversion of energy into mechanical work, and the physical and functional interfacing of nanoscale devices with the external environment. An additional important merit of this research is the emergence of multidisciplinary communities where chemists, physicists, materials scientists, biologists, and physicians are starting to work together to solve practical problems.

The field of nanomachines has come a long way since its inception. The term “molecular machine” appeared for the first time in the title of a scientific paper about two decades ago. The first monograph in the field was published ten years later, and substantially revised and expanded in 2008. The publication of hundreds of papers and of several book series, themed journal issues, and reviews is evidence of the impact of this area in the scientific community. The multitude of research articles that are still appearing in top journals shows that nanoscale machines and motors continue to attract interest. They are important topics in the courses of nanoscience and nanotechnology that are nowadays offered by most universities worldwide. Indeed, the appeal and challenges associated with these research topics constitute a strong element of attraction and motivation for students at both graduate and undergraduate levels.

Therefore, a textbook on nanomachines is welcome. In his new book, Joseph Wang describes the development, achievements, and recent discoveries in the field of nano- and microscale machines. After an introductory chapter on the fundamental aspects of nanoscale motion, the volume covers different categories of biological and synthetic nano- and microscale machines based on different propulsion mechanisms, and describes strategies for controlling the direction and the speed of motion. The challenges presented by various practical applications (e.g., drug delivery, enhanced sensing, target isolation) are discussed, and the last two chapters provide a futuristic look at prospects and opportunities.

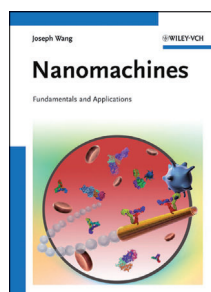
Considering the vastness of the subject and the different levels of present knowledge in the many subareas, to provide a balanced coverage in only

150 pages looks like an impossible mission. Thus, the book has strengths and weaknesses. A plus is that it is concise and gives a unified view of ultra-miniaturized machines, ranging from systems based on small synthetic organic molecules to larger constructs formed by combining biomolecular motors and microscale structures. The discussion on real-world applications and the expected technological/societal implications of nano- and micro-machines is imaginative and inspiring. Overall, the book succeeds in conveying to the reader the excitement and expectations of this amazing field.

On the minus side, a serious drawback is the emphasis given to certain subjects relative to others, which produces significant imbalances among different sections of the book. While it is certainly understandable, and in some respects desirable, that a monograph somehow reflects the author's own background and expertise, the consequence is that some important topics are treated inadequately or not covered at all. For example, Chapter 1 is dominated by a discussion of swimming-type movements, whereas it should be emphasized that nature relies on railway networks (that is, track-based motors), not on navigation, for the transport of cargos within living cells. Therefore, it is a pity that ratcheting mechanisms that underlie the functioning of motor proteins are not even mentioned in the introductory sections, and the amazing examples of implementation of energy/information ratchet schemes based on chemical species are not described.

The vast majority of the case studies included in the book involve the displacement of microstructures (particles, rods, tubes, plates) by bubble propulsion. These systems are indeed of great scientific interest and are promising for applications, but the same is also true for DNA nano-devices, which are only treated marginally at the end of Chapter 3. While the construction and operation of self-propelling catalytic systems are illustrated in detail, the discussion of supramolecular machines and motors is superficial. Small-molecule walkers are not considered, and recent landmark achievements towards practical applications of molecular machines are missing. Moreover, some choices in the organization of the chapters are questionable, such as that of presenting myosin, kinesin, and ATP synthase under the category of nanoswimmers.

Another significant limitation of this book concerns the illustrations. Graphics are of crucial importance for a book aimed at introducing newcomers to highly sophisticated (bio)chemical systems. Figures should ideally provide a clear and nicely presented description of the selected examples. Unfortunately, it seems that there has been little effort towards preparing educationally effective and eye-catching figures. Most illustrations are



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mere reproductions of the original material. In some instances the figures are poorly integrated with the corresponding text, and/or the caption does not provide sufficient information for a full understanding.

In summary, if you are not an absolute beginner and are interested in understanding the design, construction, and operating mechanisms of nanomachines, then you will probably be disappointed by this book. Conversely, if you know hardly anything about such systems and are looking for a concise textbook that can introduce you to the field

and give a taste of current research, then you should go for this one. Although you may admittedly get a distorted view of the field, it will stimulate your curiosity and provide plenty of references for further reading.

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