Nanosensors: Physical, Chemical, and Biological FREE

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nel where the highest-energy protons ever prepared by humans circulate in a vacuum chamber. Colliding in detectors, those particles re-create conditions one step closer to the Big Bang than have been produced in any other accelerator. You will visit the experiments, but will also meet the people and discover their various accents and personalities. Besides being a top scientist, Randall is also a lover of people and a perceptive reader of their personalities.

Perhaps Randall's most striking trait is courage, and it is fitting that she would, with great respect and understanding, address the burning underlying question: for a scientist, how about God, how about religion? She argues that scientists have not found any problem that demonstrably requires the intervention of a supernatural being animated with a purpose. They have, however, designed ways to establish a domain of truth based on experiments or observations that anyone can reproduce and that are related by theories that use mathematics agreed upon by all.

As a consequence of scientific endeavors, the internet allows the whole world to communicate and industry creates the most complicated machinery—for example the GPS in your car—based on past discoveries and parts built across the planet. And it all works! Yet what is the place of religion? Randall has the honesty and frankness to address the issue; she worked hard on documenting the debate, yet she never forgets that humans have souls.

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Nanosensors

Physical, Chemical, and Biological

Vinod Kumar Khanna
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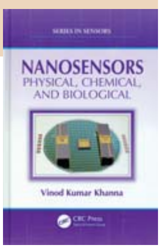

It should come as no surprise that a rapidly developing area of research is the application of nanostructured materials to sensor performance, which is constrained by the sensor material's surface properties. A plethora of books on nanoscale science and technology have been published in the past decade, and several contain chapters or sections that focus on sensing. Examples include *Nanochemistry: A Chemical Approach to Nanomaterials* by Geoffrey Ozin and André Arsenault (RSC, 2005) and *Nanostructures and Nanomaterials: Synthesis, Properties, and Applications* by Guozhong Cao and Ying Wang (2nd edition, World Scientific, 2011). Some texts have even been dedicated to the subject. They include *Nanotechnology-Enabled Sensors* by Kourosh Kalantar-zadeh and Benjamin Fry (Springer, 2008) and *Biosensing Using Nanomaterials* edited by Arben Merkoçi (Wiley, 2009).

In *Nanosensors: Physical, Chemical, and Biological*, Vinod Kumar Khanna has set himself the ambitious task of surveying the entire field—as implied by the subtitle. One challenge in writing a book that covers any fast-moving, multidisciplinary field is to strike the right balance between depth and breadth. That is particularly true for nanosensing, which brings together materials science, electrical engineering, physics, measurement science, information technology, chemistry, and biology and applies them to problems as diverse as health care, industrial process control, and environmental monitoring.

The book has some significant strengths. Among them are its comprehensive coverage and its use of illustrative calculations to enhance the more descriptive sections. The depth of presentation ranges from the basic high school level to discussions of recent research literature. The book's most likely beneficiaries are researchers in either sensor technology or nanotechnology who want to see how the two fields complement each other and can be combined in new and interesting ways to tackle important applications.

Notwithstanding the questions at the end of each chapter, *Nanosensors* is certainly not a textbook. Its rather old-fashioned structure, lack of sidebars and glossary, somewhat cluttered layout, and a few unclear diagrams make the book less student friendly than most course texts. Even its distinctive question-and-answer features, which recur throughout the book and are of some pedagogical merit, break up the flow of the text and would have been better placed in sidebars.

The dilemma the author faces in balancing breadth and depth is nowhere better illustrated than in the opening chapters. They cover such topics as semiconductor electronics, organic chemistry, and cell biology, but at a level too cursory to be of much use either as an introduction for readers unfamiliar with those topics or as a refresher for readers with prior knowledge. At the other extreme, the treatment of scanning probe microscopies is quite detailed, as are some laboratory protocols—for example, for the synthesis of gold nanoparticles. Moreover, several of the topics treated at an elementary level early in the book are later discussed in greater depth, which makes it tricky to know the intended level of detail.

The bulk of the book is structured around modalities for sensing—mechanical, thermal, optical, and magnetic, but not electrical—and around the different types of molecular sensors. Inevitably, such a structure must be arbitrary, since molecular sensors are ultimately based on an underlying physical modality to generate the signal. Thus microcantilevers are introduced in the mechanical sensors chapter but then reappear in the nanobiosensors chapter in the context of surface modification and DNA analysis. Metallic nanoparticles, carbon nanotubes, and silicon nanowires similarly crop up at many places throughout the book; sometimes the discussion is of their fundamental physics and material properties and sometimes of their use in chemical or biological sensors. Because such important topics are scattered throughout, the book would have benefited from a more comprehensive index.

The final chapter, which looks at future trends in nanosensing, is useful: It highlights the breakthroughs in overcoming the limitations of conventional sensors and the remaining challenges in deploying the technology. *Nanosensors* may appeal to researchers who would benefit from a comprehensive text, and is better when read here and there than digested cover to cover.

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Polymer Physics

Applications to Molecular Association and Thermoreversible Gelation

Fumihiko Tanaka
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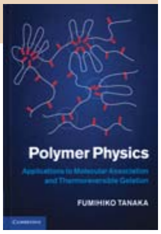

At its foundation, soft-matter science is supported by macromolecular physics, which is intimately linked with statistical mechanics and such phenomena as critical behavior and Brownian motion. A soft-matter scientist may wonder whether we really need any new books in polymer physics, given that we already have two brilliant works, *Scaling Concepts in Polymer Physics* by Pierre Gilles de Gennes (Cornell University Press, 1979) and *The Theory of Polymer Dynamics* by Masao Doi and Sam Edwards (Clarendon Press, 1988). Those masterpieces, faithful companions of any scholar in soft matter, may hardly be surpassed. Yet scientists who conclude that no more is needed would be wide of the mark.

In the past, polymer physics mainly dealt with nonspecific polymer–solvent interactions typified by short-range dispersion forces or, in the opposite limit, by long-range electrostatic effects in polyelectrolyte solutions. But with the expansion of polymer chemistry and the introduction of novel systems such as block copolymers, telechelic structures, and polymer microgels, scientists in the field must now consider how, for example, hydrogen bonding is affected by polarity and entropy. In addition, to understand the complex interplay between polymers, surfactants, and proteins, we will need to get a better handle on the aggregation behavior of amphiphilic molecules.

Bridging that gap, at least in part, is one of the goals of Fumihiko Tanaka's *Polymer Physics: Applications to Molecular Association and Thermoreversible Gelation*. The book hardly aims to be comprehensive; rather it focuses on the topics specified in its restrictive subtitle. In addressing them, Tanaka is guided by his training as a physical chemist in the prestigious school of physicist Sam Edwards, who pioneered the use of Feynman diagrams to describe the statistical properties of disordered systems; Tanaka also acknowledges the informal but influential role played by Japanese mathematical physicist Ryogo Kubo.

Tanaka's coherent and organic framework enables him to set very different systems in a common context and discuss their structures and phase behaviors in depth, at least within a Flory–Huggins mean-field approach. The book fully exploits percolation and scaling concepts in its discussion of network structure and topology. It also meticulously discusses thermoreversible gelation driven by conformational changes, a phenomenon of particular value for understanding the phase behavior of protein solutions. Also noteworthy is the author's attempt to provide a solid background for micellar aggregation in amphiphilic polymer solutions, a topic still not fully understood due to the subtle interplay between aggregate morphology and intermicellar interactions. As a physicist mostly dealing with colloids, I also appreciated the thoughtful discussion of cooperative hydration effects in poly(*N*-isopropylacrylamide) microgels, which are extensively exploited as model systems of soft spheres whose size can be thermally tuned.

Of course, the book's narrow focus leaves out many interesting questions. For example, it only sketches the relation between the formation of polymer networks and depletion-induced gelation in colloids. Its analysis of dynamic effects is confined to macroscopic rheology, and microscopic dynamics in arrested systems, currently a matter of great interest in soft-matter science, gets only a brief treatment. Nonspecialists may wish for more attention to the general theory of polyelectrolytes and possibly a more detailed comparison with experimental data on gelation. I admit, however, that expecting this