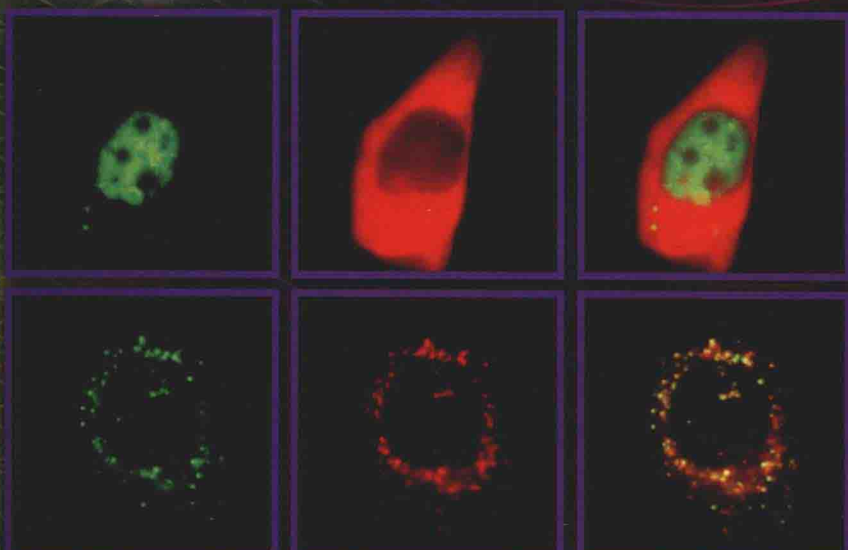
Nanopatterning and Nanoscale Devices for Biological Applications



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Nanopatterning and Nanoscale Devices for Biological Applications

Devices, Circuits, and Systems

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Preface

Devices utilizing microscale fluidic components (microfluidics) and microelectromechanical systems have become an important focus in a variety of disciplines, including biology and biological engineering, and have revolutionized multiple technological fields, from medical electronic devices to diagnostics and therapeutics. In the last decade, however, there has been additional multidisciplinary effort to gain control over biological systems on the nanoscale, by reducing the size of key elements in such devices down to the submicron scale or by controlling certain substrate properties such as topography and chemistry. These nanoscale approaches are extending the current capabilities of biological research by allowing the experimenter excellent control over multiple system parameters on a molecular scale—while at the same time offering increased performance in terms of data accuracy, precision, and collection time.

This book provides valuable insight into the latest developments in nanoscale technologies for the study of biological systems, in three parts. The first part focuses on device fabrication methods targeting the substrate on the nanoscale through surface modification, for example, by tailoring wettability. This section of the book also explores the generation of nanostructured biointerfaces and bioelectronics elements. This includes a discussion of the physics and modeling of DNA structures in biosensors as a perfect example of nanoscale biological engineering. We will also take a look at microfluidically generated droplets as reactors enabling nanoscale sample preparation and analysis. The second part is devoted to biosensors and integrated devices with nanoscale functionalities. From sensors that monitor the success of tissue implants to nanofluidic devices for nucleic acid analysis, this section of the book gives an overview of the most common and, therefore, perhaps the most relevant biosensor technologies that are based on nanoscale principles. The third part is devoted to a general discussion of the biological applications of nanoscale devices, including a review of nanotechnology in tissue engineering and regenerative medicine. Here, we are particularly interested in utilizing engineering approaches on the nanoscale to generate, control, and monitor tissues, and we discuss bone tissue and vascular structures as typical application areas.

The target audience is academic researchers primarily in biological and biomedical engineering, but the book is also accessible to researchers in related disciplines such as electrical engineering, biophysics, and biochemistry. We thank all the contributors for their insights into the newest technologies and for sharing their knowledge with our audience. We are hopeful that this book will stimulate the reader to pose new questions and develop new solutions and applications in the effort to advance nanoscale engineering in biological fields.

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Editors

Šeila Selimović is currently an AAAS Science and Technology Policy Fellow in Washington, DC, working on science diplomacy issues relating to energy security and scientific cooperation. Previously, she was a postdoctoral research fellow at Harvard Medical School and Brigham & Women's Hospital in Boston, Massachusetts. An author of over 60 research articles, book chapters, and editorials, Dr. Selimović developed an interest in the development of microfluidic and microelectromechanical systems platforms for applications in biophysics and biological engineering. A special emphasis of her work is on biosensors and organ-on-a-chip platforms and has been funded by the US Army. Her research interests include the physics of microscale flows, protein crystallization, and colloidal suspensions, as well as rheology and microrheology. Dr. Selimović earned her PhD and MSc in physics from Brandeis University, where she was a recipient of a 2-year National Science Foundation traineeship (IGERT), and her Bachelor of Arts, also in physics, from Wellesley College. She is a member of Sigma Xi. Outside her work, she enjoys playing the piano and running in long-distance races. She can be contacted at sselimov@gmail.com.

Krzysztof (Kris) Iniewski manages R&D at Redlen Technologies, a start-up company in Vancouver, Canada. Redlen's revolutionary production process for advanced semiconductor materials enables a new generation of more accurate, all-digital, radiation-based imaging solutions. Kris is also president of CMOS Emerging Technologies Research Inc. (www.cmosetr.com), an organization of high-tech events covering communications, microsystems, optoelectronics, and sensors. In his career, Dr. Iniewski has held numerous faculty and management positions at the University of Toronto, the University of Alberta, Simon Fraser University, and PMC-Sierra Inc. He has published over 100 research papers in international journals and conferences. He holds 18 international patents granted in the United States, Canada, France, Germany, and Japan. He is a frequent invited speaker and has consulted for multiple organizations internationally. He has written and edited several books for CRC Press, Cambridge University Press, IEEE Press, Wiley, McGraw-Hill, Artech House, and Springer. His personal goal is to contribute to healthy living and sustainability through innovative engineering solutions. In his leisure time, Kris can be found hiking, sailing, skiing, or biking in beautiful British Columbia. He can be reached at kris.iniewski@gmail.com.

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