Preface

Of all things natural, light is the most sublime. From the very existential belief of the origins of the universe to its role in the evolution of life on earth, light has been inextricably woven into every aspect of our lives. I am grateful to Springer-Verlag and Thomas Scheper for this invitation to organize this volume that continues to expand the use of light to create next generation sensing applications. Indeed, the very act of expanding the frontiers of learning and knowledge are referred to in many languages and cultures as enlightenment. Early optical instruments relied largely on simple combinations of mirrors, prisms and lenses. With these simple devices, substantial progress was made in our understanding of the properties of light and of its interactions with matter.

Things got more complicated with the evolution of optical instruments in laboratory use. Early systems used bulky and expensive hardware to generate light, split it into the desired wavelengths and finally collect it for analysis. The discovery of the laser pushed the technology further, but did not do much to make its adoption more widespread as the lasers themselves were large and required substantial electrical power to operate. The true revolution is just beginning. Advances in microelectronics have resulted in the possibility of truly low-cost (using the consumer electronics industry as a parallel) devices that exploit optical measurement technology.

In this volume, several frontier articles assess the latest approaches to measure a variety of parameters. Lam and Kostov start out with a survey of instrumentation that is enabling low-cost optical sensors to become a reality. The consumer electronics revolution, coupled with low-cost LED (and laserdiode) sources that have replaced bulky lasers, is the key to making compact devices that rival the performance of expensive laboratory systems. Ray et al. review the unique behavior of light-excited surface plasmons and the resulting coupling to fluorescence in proximity to metal substrates. This approach promises unprecedented increases in measurement sensitivity. Henriques et al. examine how IR spectroscopy can be used to monitor real time antibody production bioprocesses. Such techniques are critical to create robust manufacturing processes for biological products. Indeed, it has been remarked that processes for producing potato chips are better monitored than those for producing biologics! Reardon et al. describe novel sensors that can be used to monitor environmental parameters that are based on clever combinations of molecular biology approaches and optical measurement techniques. Leeuwenhoek's microscope of over three centuries ago was one of the first applications of an optical instrument, when he observed the very first "animalcules" or bacteria. Rudolph et al. reprise this and describe applications for real time sizing and counting of cells growing in bioreactors, which is a critical measurement in any fermentation or cell culture process. Finally, Tolosa examines a novel biomimetic approach, where Nature's own exquisitely sensitive and selective molecular recognition machinery is converted into innovative optical sensors.

These articles are a very small part of the spectrum of optical sensor technologies, but are representative of the diverse applications that are possible. The continuing evolution in materials will continue to drive the evolution of light-based sensor technologies and these articles portend an even more exciting future.

I hope that the reader will enjoy learning from these chapters as much as I did in putting them together. Special thanks to Ms. Ingrid Samide for patiently taking care of the difficult background work.

Baltimore, Summer 2009 Govind Rao

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