



## Photonic Technologies for Biomedical Applications

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### Abstract

Applying photonic technologies to address biomedical challenges has unique advantages and therefore attracts much research attentions. In the book "Handbook of Photonics for Biomedical Engineering", edited by A. H.-P. Ho, D. Kim, and M. G. Somekh, many recent developments in the field of biophotonics are summarized in an organized way. In this book review, we will provide a guideline for interested readers by briefly introducing the contents in the book.

### Keywords

Biophotonics; Imaging; Biosensing; Biomedical engineering; Optical manipulation

### Introduction

Biophotonics has been emerging as a forefront research field because it provides various optics-based techniques that are of great potential in addressing challenges in all aspects of biomedical engineering [1,2]. Not only can light be used for high-speed, high-accuracy imaging and sensing in biosystems [3,4], it also offers the possibility of noninvasive microscale manipulation of bio species as well as boosts the development of effective disease treatment therapies [5-7]. The recent development of all these areas in biophotonics are summarized in the monograph edited by A. H.-P. Ho, D. Kim, and M. G. Somekh [8], with their expertise covering industrial fabrication and packaging of photonics structures and devices, laser technology, fiber optics, nanophotonics and plasmonics, biophysics imaging, sensing, and acoustic microscopy. The main purpose of the handbook is to provide a guide to both researchers working in optical engineering and biomedical applications, offering them a powerful toolbox in the highly interdisciplinary field.

This handbook emphasizes on introducing various passive and active biophotonic techniques. The former includes employing optical sensing, imaging, and microscopy techniques for *in vitro* and *in vivo* applications. The latter mainly covers the use of light for micromanipulation and therapeutic applications. Passive biophotonic sensing and imaging techniques are very important for diagnosis of diseases and investigation of biochemical processes. Chapters in the book cover developments in high-sensitivity optical sensing techniques, including flow cytometry combined with confocal microscopy, surface-enhanced Raman spectroscopy, surface plasmon resonance spectroscopy, and sensing based on high-Q whispering gallery microcavities, photonic crystal optical fibers, and optofluidic lab-on-a-chip devices. The book further elucidates various

novel optical imaging techniques that can greatly extend biomedical explorations in *in vivo* experiments, such as diffuse optical methods, photoacoustic imaging, and optical coherence tomography. Enhanced microscopy techniques to achieve super-resolution and other desired characteristics are also summarized. For example, fluorescence lifetime imaging, plasmonic microscopy, and evanescent waves can be applied to achieve super-resolution sensing of the bioenvironment. Nonlinear optical microscopy provides improvements in penetration depths, spatial resolution, and selectivity.

Apart from the passive biophotonic techniques, active light micromanipulation and therapeutic treatment are of vital importance, especially for future clinical applications. The book discussed using optical tweezers to manipulate cells or particles and applying photochemistry to treat a range of cancers, i.e. photodynamic therapy.

In addition to all these techniques, the book further introduced the recently emerging biophotonic materials and devices, including plasmonic nanocrystals, cadmium-free quantum dots, devices with extraordinary optical transmission, and miniaturized fluidic devices.

In summary, the handbook is well organized and balanced. Many important aspects in biophotonics are covered. The book provides an excellent reference for researchers with background in applied physics, biomedicine, analytical chemistry, and optical engineering, if they would like to devote more efforts in applying light science and technology to address biomedical challenges. Although the field is fast developing and novel techniques are appearing almost every day, I believe interested readers can still find a lot of useful information and insights from this handbook without the need of reading vast amount of literatures.

### Acknowledgments

The author acknowledges the support from CUHK Direct Grant (Ref. No. 2016-17, Project Code 4053238).

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Received: December 12, 2017 Accepted: January 12, 2018 Published: January 22, 2018

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