

Book Review of Advanced Fluorescence Reporters in Chemistry and Biology II: Molecular Constructions, Polymers and Nanoparticles

Advanced Fluorescence Reporters in Chemistry and Biology II: Molecular Constructions, Polymers and Nanoparticles. Edited by Alexander P. Demchenko (National Academy of Sciences of Ukraine). From the series, Springer Series on Fluorescence, 9. Edited by O. S. Wolfbeis. Springer-Verlag: Berlin, Heidelberg. 2010. x + 460 pp. \$409. ISBN 978-3-642-04699-5.

Spectroscopy enables chemical identification and quantitation in a diverse range of environments, and the development of optical probes has been critical to advancing the field of fluorescence sensing. This book covers advances achieved through nanoscience. An underlying theme in this monograph is that nanoscale probes extend the capabilities of fluorescence sensing by enhancing sensitivity, selectivity, stability, and efficiency. The topics cover the photophysical features and synthesis of nanoscale emitters, including quantum dots, molecular aggregates, metallic clusters, and conjugated polymers.

The book is divided into five sections, the first being an overview of fluorescence sensing. A comparison of molecular dyes and semiconductor quantum dots highlights key parameters relevant to this type of sensing, and the value of this discussion extends beyond these specific examples. Signal transduction via enhancement of fluorescence is evaluated from the perspective of the different types of bonding and structural changes that accompany recognition of analytes. For assays requiring enhanced sensitivity, avenues for signal amplification via chemical reactions and probe design are presented. Organized assemblies of small molecule fluorophores influence quantum mechanical interactions, thereby allowing novel modes of fluorescence detection based on energy transfer.

In the next two chapters, two types of noncovalent complexes of dyes are discussed. First, J-aggregates that form with DNA and proteins are considered within the context of specifically detecting these biological templates. Second, guest–host interactions involving cyanine and squaraine dyes are discussed because these complexes enhance the stability, brightness, and aqueous solubility of these fluorophores. Polymers, silica, and dendrimers that are impregnated with organic chromophores are evaluated in the next four chapters. Several factors dictate the choice of a specific nanomaterial, including permeability that determines the extent to which the fluorophores interact with their environment and chemical modifications that influence surface derivitization and enhanced functionality, e.g. magnetism, metal-enhanced emission, and light harvesting. The two subsequent chapters are devoted to silver and gold clusters that are distinguished from their larger nanoparticle counterparts by a sparser density of electronic states, thereby favoring radiative relaxation. Coordinating ligands stabilize these small clusters for use in aqueous environments and dictate their high fluorescence quantum yields. The optical properties of these noble-metal clusters enable

novel modes of detecting analytes, as illustrated in high background environments.

The last three chapters focus on conjugated polymers in which the chromophores are strongly coupled via overlapping p-orbitals. One mode of detecting analytes is accomplished by perturbing the effective conjugation lengths, through localized binding that creates an exciton trap, aggregation that results in self-quenching, or conformational changes that modify the electronic states. The power of these fluorescent reporters is demonstrated by the ability to modify the polymer synthetically so as to allow the detection of a wide range of analytes. Another avenue of detection utilizes the light-harvesting capabilities of conducting polymers, thereby enhancing the emission of acceptors in a FRET arrangement. With an amplified response, sensitive detection of DNA and proteins can be achieved.

In summary, this book is a comprehensive overview of the different types of nanoscale probes that have been and are currently being developed for sensing of analytes. The timely reference section allows the reader to locate key references to the primary literature for expansion of the material covered. This book is a valuable resource that covers the synthetic, photophysical, and theoretical aspects of this diverse field of research.

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