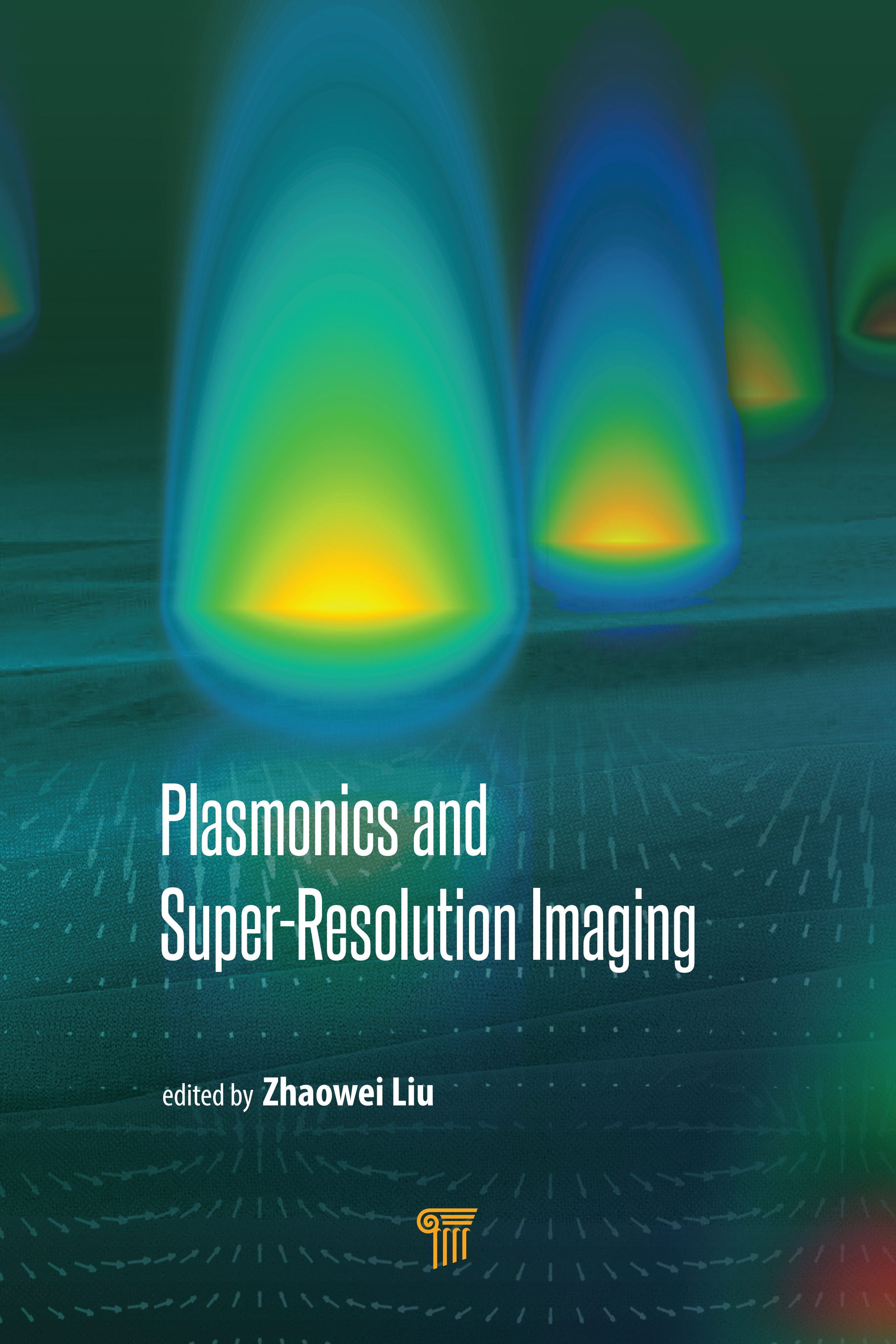
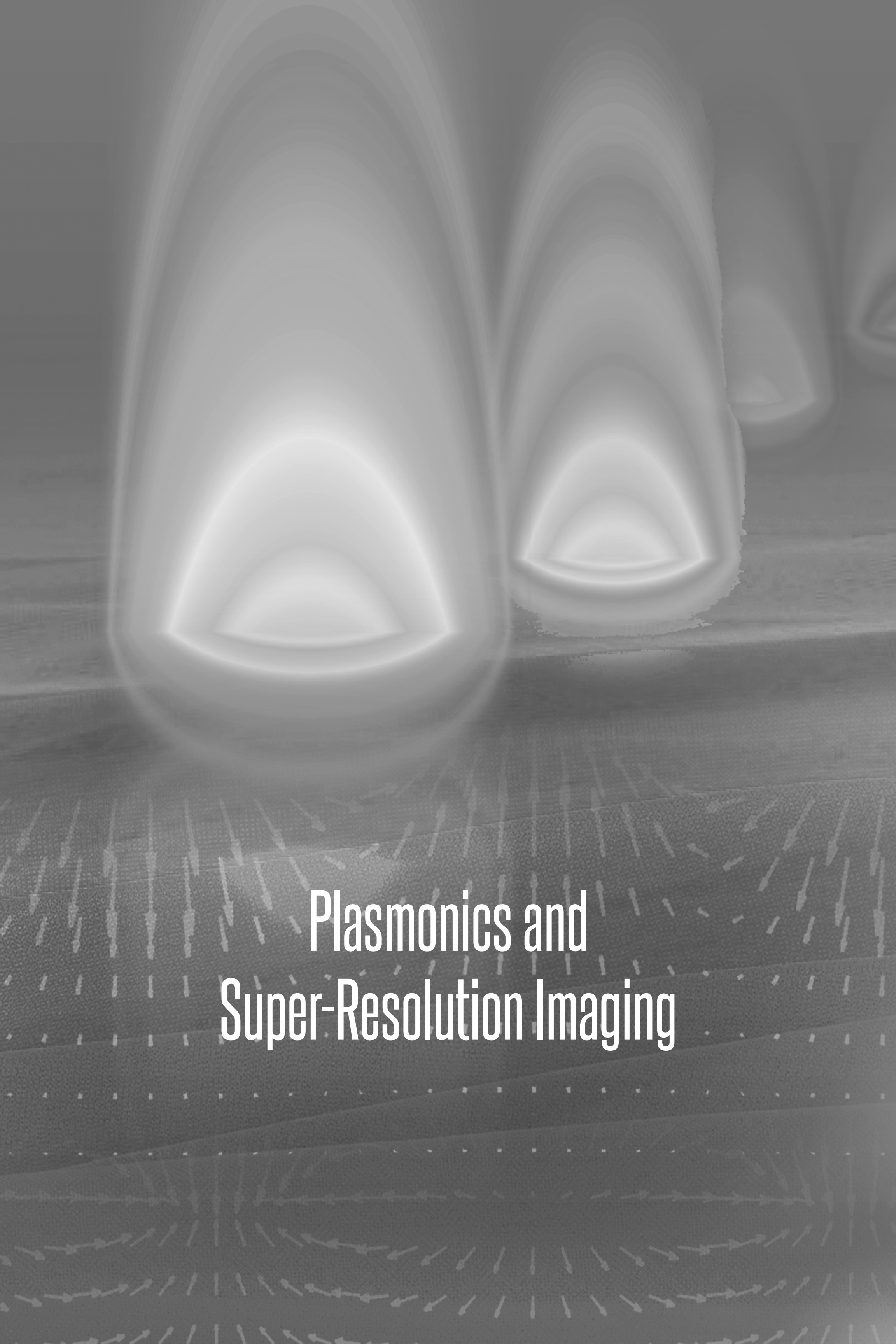


Plasmonics and Super-Resolution Imaging

edited by **Zhaowei Liu**



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Preface

Surface plasmons are collective electron oscillations at the interface between a metal and a dielectric. They were first predicted in 1957 by Rufus Ritchie, and then followed two decades of extensive exploration. Stemming from this first wave of research, the surface plasmon–based biosensor was commercialized in the early 1990s, and it is probably the most important application that can be identified now.

With advances in nanomanufacturing, the field of plasmonics was "rediscovered" from the late 1990s to the early 2000s, and a variety of contexts, including nanoscale light guiding in metal waveguides, surface plasmon–mediated anomalous light transmission, and the discovery of the perfect lens and the superlens, were predicted and experimentally demonstrated. Plasmonics has now become a major and perhaps the most fascinating part of nanophotonics.

Imaging is an important field of optical science and technology. Extending the resolution of a microscope into the nanoscale and breaking the diffraction limit have been long considered the holy grail in optics. The perfect-lens concept proposed by John Pendry in 2000 brought microscopy into a new era. A negative-refractive-index lens can not only refract light negatively but also recover the "lost treasure" carried by the evanescent waves, thus forming images with perfect resolution. This stimulated the later flourishing of the field of metamaterials, artificial materials with extraordinary material properties that do not readily exist in nature, including a negative refractive index.

Although negative-refractive-index materials at visible frequencies have been demonstrated in laboratories around the mid-2000s, the quality of those materials is simply not high enough for any practical imaging applications. Meanwhile, negative-permittivity materials, that is, plasmonic materials, have proved to be the most practical solution for super-resolution imaging. The unique dispersive property and resonant nature of surface plasmons lead to enhanced optical near-field and subwavelength confinement in space, forming the basic foundations for plasmonic-enhanced super-resolution and high-contrast microscopy technologies.

This book, therefore, was written to cover some major developments in the field of applying plasmonics for various imaging technologies and potential applications. It is a comprehensive and valuable reference for both students with an elementary knowledge of electromagnetism and applied optics, as well as researchers. The chapters were selected from a relatively large pool of work in order to provide readers with a balanced view of the developments in the field. The book starts with a few chapters describing different schemes to incorporate plasmonic principles for super-resolution microscopy. These include the far-field superlens, the metalens, metasurface-based lenses, surface plasmon microscopy, and the hyperlens. Subsequent chapters describe technologies that combine plasmonics with other established imaging methods, such as structure illumination microscopy (SIM), stimulated emission depletion (STED), and single-molecule spectroscopy. The book closes with a few chapters discussing specific applications in nanolithography, plasmonic coloring, and bioimaging. I hope readers find this book useful.

Zhaowei Liu