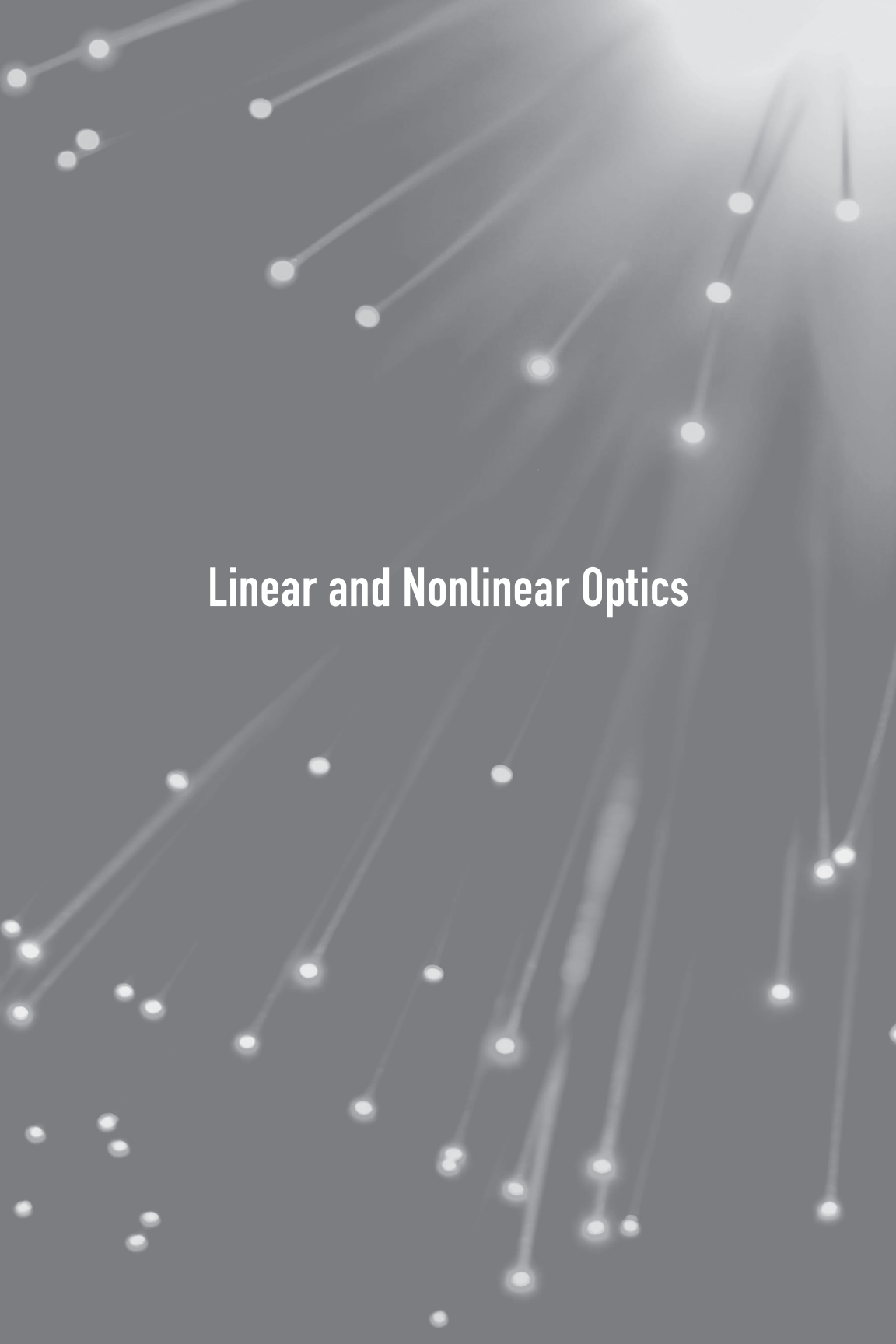
Kitsakorn Locharoenrat

Linear and Nonlinear Optics

Materials, Properties, and Applications



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Linear and Nonlinear Optics: Materials, Properties, and Applications

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Preface

This book emphasizes the underlying principles of the linear and nonlinear optical properties of materials, as well as their implementation and applications to help students and researchers in physics and related fields to develop their physics insight. Several examples presented throughout this book and the problem sets in each chapter will enable readers to develop their skills and to measure their understanding of each topic step-by-step. The book will be a helpful tool to solve problems both in classroom and in real life.

The textbook is divided into two parts. Part I, Linear Optics, is composed of Chapters 1–6. Chapter 1 describes bimetallic nanoparticles in dielectric media that show a noticeable band shift of electromagnetic field around them, owing to the plasmonic effect applicable for enhancing and quenching fluorescence intensities of the dye molecules. Concentration dependence of the fluorescence quantum yield and fluorescence polarization is related to the energy transfer between the metals and dye molecules. The integration of bimetallic nanoparticles to dye molecules shows the selective and sensitive detection of trace amounts of heavy metals such as mercury ion at the nanometer level. Furthermore, the integration of bimetallic nanoparticles to dye molecules during excited state as luminescence enhancer improves image contrasts of artificial latent fingerprints and serves as an information bank of the donor, which has high importance in forensic inspection and biomedical diagnosis. Chapter 2 shows that the dosage of ZnO nanoparticles under UV exposure is related to the levels of the oxidant generated from electron–hole pairs and the human breast cancer cells via phototoxic activity. Integration of bimetallic nanoparticles to the ZnO matrix promotes broadening of the absorption spectrum from the ultraviolet to the visible wavelength. The photocatalytic activity is improved by surface plasmon resonance and Schottky junction effect. The integration of coumarin-153 to the ZnO matrix also shows effective and stable photovoltaic effect. Higher absorbance indicates that coumarin-153 has an important role in light harvesting.

Coumarin-153 absorbs light in higher frequency regions, transferring their electrons to the conductive band of ZnO nanoparticles and enhancing the semiconductive activity of ZnO. Chapter 3 explains that the dye removal kinetics by Fe_3O_4 magnetic nanoparticles under pulsed white light originates from surface adsorption and photocatalytic degradation. A reduction of fluorescence quantum yield of rhodamine 6G conforms to the improvement of dye removal. Chapter 4 describes the uniformity of the electron transport layer stamped on a blue-OLED, serving as an alternative for the deposition of an organic thin film. On the other hand, the white-OLED based on p-i-n structure shows great power performance compared to the traditional structures because the high hole–electron ability maintains an effective electron–hole balance. Chapter 5 introduces the double-layer shielding tank design to safely store radioactive waste. The weight and cost of the tank made from the designed materials are computed via the optimization model and the contour plotting method. Chapter 6 explains photon propagation through the multilayer structures of a human tissue model. A point source and two photo detectors to be set on human skin are dependent on the distribution and penetration depth of the photon. A photon packet transfixed through the skeletal muscle can fairly detect the contraction and relaxation states of the skeletal muscles for clinical tests.

Part II, Nonlinear Optics, is composed of Chapters 7–10. Chapters 7 and 8 cover the basic topics on nonlinear optical effects. They focus on general concepts such as electromagnetic theory, nonlinear medium, and wave propagation. Chapters 9 and 10 focus on more advanced concepts such as second harmonic generation, phase matching, optical parametric interactions, different frequency generation, sum frequency generation, tunable laser, and optical resonant oscillator.

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