Preface

This thesis is submitted to the Institute of Electro-Optical Engineering at National Chiao Tung University in partial fulfillment of the requirements for the doctoral degree. In addition, this thesis is intended to present diverse applications of planar optics, thereby exciting people's interest in planar optics design.

Overview of this thesis

In this thesis, planar optics is classified as two categories. 1) **Typical type** is defined as a device with its input and output terminals at the ends of the device; one example proposed herein is the **planar zoom module (PZM)**. 2) **Extended type** possesses its input and output planes at the bottom or top surface of the device; two demonstrations presented are **multi-zoned light enhancing layer (MZ-LEL)** and **patched wire grid polarizer (WGP)**.

Chapter 1 and 2 are the introduction part of this thesis. The motivation and organization of this thesis and basic principles of planar optics are elucidated in these two chapters. The following chapters present the main works of this thesis. Brief backgrounds and contributions of these works are described as follows.

Conventional zoom lens performs its zoom function by longitudinal movement and requires a sufficient volume for the whole set. Then volume issue causes the geometric limitation for the zoom lens design. To miniaturize the zoom lens set, a **PZM** is proposed (Chapter 3) by means of the planar optical structure and the transverse zooming. Meanwhile, the PZM is utilized to scale the laser beam and serves as a multi-magnification laser beam expander. In our design example, confocal paraboloid mirrors are utilized as reflectors to realize the magnifications. The simulation results have demonstrated not only the magnifications but also negligible aberrations. Compared with previous works, the multi-magnification laser beam expander has the features of the compactness and the suppressed aberrations.

Although micro-lens arrays have been utilized as a light enhancing layer (LEL) to enhance the light efficiency of organic light emitting diodes (OLED), a large gain factor discrepancy (~50%) between simulation and measured results remains an issue. To overcome this issue, **MZ-LEL** is proposed (Chapter 4) with a multi-zoned surface profile, which can fit the fabrication features and results in a precise profile. Meanwhile, the modeling accuracy is improved by a new model combining a ray-tracing model with Fresnel's equations. Compared with previous micro-lens LELs, the MZ-LEL not only enhances the light efficiency of OLED panel but also improves the fabrication precision and modeling accuracy, resulting in a suppressed gain discrepancy of 4%.

Combining with proper optical components, a WGP with sub-wavelength metal gratings has been proposed as a LCD polarizer with high polarization efficiency. However, the fabrication of sub-wavelength gratings is confronted with a difficulty in size extension (the size of conventional WGP is less than 100 cm^2). Although the patching method is one solution to enlarge the size, seams between adjacent patches cause a reduced extinction ratio, an evaluation factor of polarization efficiency. To analyze such a seam effect, the rigorous coupled wave analysis (RCWA) is utilized (Chapter 5). Since conventional RCWA methods prefer only the ideal structure without seam, for the application to **patched WGP** with seams, issues, such as efficiency pattern scaling, occur. Thus, several strategies are proposed to solve the modeling issues and to enable the commercial RCWA tool to analyze both narrow- (the seam width is less than wavelength) and wide-seam (the seam width is larger than 10 times of the wavelength) cases. Hence, the proposed method combining the RCWA and strategies can benefit the design and optimization of WGP patching.

Finally, brief conclusions of these planar optical components as well as their further applications are presented in Chapter 6 to induce more inventions of planar optics for benefiting human lives.