Chapter 7

Conclusion

As science and technology advance by leaps and bounds, the development of liquid crystal display technology is rising and flourishing in the past few years. However, low light efficiency and power consumption are still the improvable drawbacks of LCDs. Therefore, an integrated lightguide with planer polarizing beam splitter on its top surface has been proposed to perform polarization conversion which can fully utilize light, so as to increase light efficiency. Conventional polarizing beam splitters are usually large, bulky, and incompact, which are not applicable for integrated lightguide. Thus, sub-wavelength grating, a PBS which is much thinner than conventional PBS, is utilized to separate two mutually orthogonal polarized lights.

Sub-wavelength grating is of period smaller than wavelength of incident light, the grating behaves more like a uniaxial medium than a diffractive optical element. This effective medium has large birefringence, which can be controlled by its geometrical parameters and materials used. The simulated results of sub-wavelength grating performed by GSOLVER predict that metallic sub-wavelength grating with period, duty cycle, and depth of 0.2 μm, 50%, and 0.1 μm, respectively, provides high efficiency of light separation over the visible spectrum range. Efficiencies of p ray transmission and s ray reflection are about 80% and above 97% respective. Besides, the addition of a dielectric layer with thickness of 0.2 μm is helpful for shortening the resonant wavelength where a sudden decay occurs. Therefore, most of p rays can be transmitted through the sub-wavelength grating with double-layered structure, while s rays are reflected.

To confirm the simulated results, the designed sub-wavelength grating is fabricated by electron beam lithography technology combining with lift-off and reactive ion etching processes. The sub-wavelength grating made of aluminum has been successfully fabricated on quartz substrate. However, the cross-section of the fabricated grating is not exact a square but a triangle. In addition, the evaluated results show a matched curves of calculated and measured efficiencies of reflection. Nevertheless, deviations of at most 10% are observed from the comparison. With regard to the fabrication of sub-wavelength grating with double-layered structure, the conditions of etching aluminum and SiO_2 by using ICP-RIE are still under testing, the experiments will be continued.

By applying the fabricated sub-wavelength grating on the top surface of the integrated lightguide, 80% of P-S conversion, which can greatly increase the light utilization, can be carried out. Thus, low light efficiency and power consumption are improved. With the characteristics of light in weight, thin in thickness, and high in efficiency, the fabricated sub-wavelength grating can be also employed in systems where polarizer or PBS is the essential optical component except the proposed lightguide.