Chapter 6

Conclusion and Future Work

6.1 Conclusion

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 0.05 μm, respectively, provides higher efficiency of light separation over the visible and the near infrared spectra with rectangular profile. Efficiencies of TE-mode reflection and TM-mode transmission are about 90% and above 41% respective.

To confirm the simulated results, the designed sub-wavelength grating is fabricated by interferometric lithography technology combining with UV-nanoimprint lithography and oblique e-beam evaporation 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 measurement, the fabricated grating with 200nm period can provide 53% and 23% efficiencies of TE-mode reflection and TM-mode transmission over the visible and the near infrared spectra.

6.2 Future Work

6.2.1 New Grating Size Design for Visible Spectra Utilization

Low light efficiency remains a significant technical barrier in the developement of liquid crystal displays (LCDs). One of dominated factors is polarization loss. In the few years, the conception of applying sub-wavelength grating to the polarizer has been proposed to improve light efficiency, and the efficiency of light separation is better than the conventional polarizer. Owing to the simulated result shown in chapter 4, the light separation efficiency of the fabricated sub-wavelength grating in the thesis is not good enought for the visible spectra using. If the subwavelength grating is suitable for the entire visible spectra to get high light separation efficiency, the grating period needs to be smaller than 200 nm. As a result, the interference angle may try to be increased to reduce the generated gating period, as shown in Fig. 6.1. Through the grating with smaller period generated, the light separation efficiency can get better.

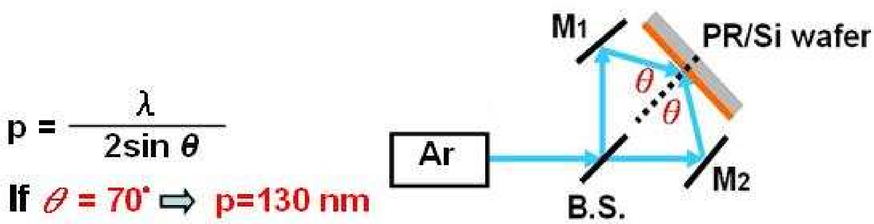

Fig. 6.1 Interferometric lithography with new incident angle θ

6.2.2 Fabrication Modification for Efficiency Improving and Size Expanding

Besides, the smoother the grating surface is, the higher light separation efficiency will be.

An etching process will be tried after imprinting to smoothen the surface of the fabricated grating to enhance the efficiency. In addition, according to the display area becomes wider and wider, interferometric lithography is proposed to replace e-beam direct writing in the thesis. But the main constraint in interference area comes from the size of the optics, especially the beam size expanded by objective lens. Following, the interference pattern will try to pieced-up together or the imprint process will combine "step and repeat" method for enlarging the fabricated grating area efficiently to adjust to the wide-sized display development. The step and repeat method is shown in Fig. 6.2.

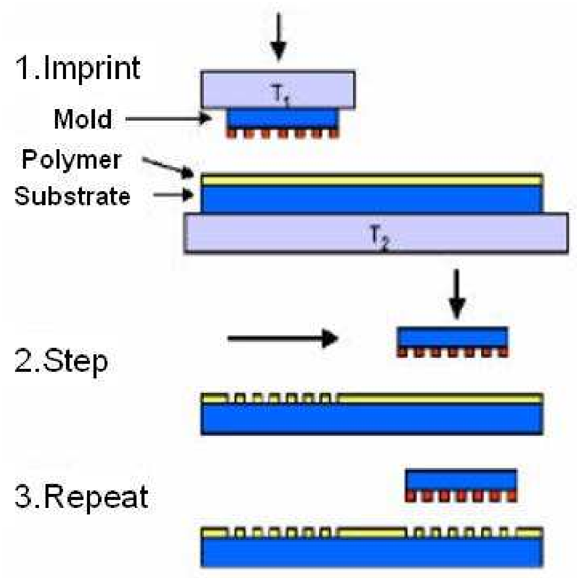

Fig. 6.2 The step and repeat method