以奈米壓印技術製作次波長光柵

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摘要

次波長週期性結構在光學上可應用於光柵、雷射共振腔、光子晶體等元件。製作週期性結構的方式雖有很多種，但要以光學的方式來製作次波長的週期性結構並不容易，其原因在於光有繞射現象，這對於結構的製作有非常大的影響。又由於以往的次波長週期性結構的作法常採用電子束直寫，在製作大尺寸時將會費時且高成本，故我們將提出新的次波長週期性結構製程，以期在大尺寸次波長光柵偏極片的製作上有所突破。

本論文的主要貢獻在於設計與製作大尺寸高效率平面型偏極光分光器(PBS)，而實驗中，我們結合干涉微影 (IL) 與奈米壓印 (NIL) 來製作所設計的次波長光柵。干涉微影技術可用於製作次微米的週期性結構，同時將之與奈米壓印技術結合以製作所提出的次波長光柵，製程的改善使得曝光面積可提高至約 1 cm^2。模擬結果中顯示，具有週期、duty cycle 與深寬比分別為 0.2 μm、50%與 1 之次波長光柵，在近紅外光範圍內可提供 90%之 TE-mode 反射效率與 80％之 TM-mode 穿透效率。

Fabricating Sub-wavelength Grating Using Nanoimprint Lithography

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Abstract

Sub-wavelength periodic structures have many applications in optical devices, for example, gratings, laser cavities, and photonic crystals, etc. The periodic structures can be fabricated by several methods. However, it is not easy to make sub-micron structures with optical methods. Because of the diffraction of light, the structure is limited to the size of wavelength. Besides, fabricating a large-sized sub-wavelength periodic sturcture is time-comsuming and costly owing to the usual fabrication of e-beam direct writing. Thererfore, we will propose a novel process to fabricate a sheet of sub-wavelength grating suitable for LCDs.

The objective of this thesis is to design and fabricate a large-sized high efficient planer polarizing beam splitter (PBS). In experiments, the sub-wavelength grating was fabricated by combining interferometric lithography (IL) and nanoimprint lithography (NIL). Interferometric lithography is the preferred approach to produce periodic structures with sub-micron period; meanwhile, combines with nanoimprint lithography to fabricate the proposed sub-wavelength gratings. The improvements in processes can increase the exposure areas to about 1 cm^2. The simulated results show that the sub-wavelength grating, which consists of period, duty cycle, and aspect ratio of 0.2 μm, 50%, and 1, respectively, provides 90% of TE-mode reflection efficiency and 80% of TM-mode transmission efficiency in the near infrared spectrum range.