微極化分光器應用於自由空間型微光學讀寫頭

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摘要

極化分光器在光電系統上是一個很重要的元件，主要用來將光分成兩個極化方向互相正交的光束。在光學讀寫頭上，極化分光器扮演一個不可或缺的角色。由光源打出的光經極化分光器後分成橫向電波(TE)及橫向磁波(TM)模式。一般的極化分光器主要是利用雙折射晶體或次波長光柵來建構；但前者有體積大的缺點，而後者的成本則過於昂貴。

本論文主要利用微機電製程技術來設計與製作體積小、重量輕以及相容於自由空間型光學讀寫頭之紅光及藍光波段的微型極化分光器。在設計上，我們利用氮化矽薄膜在可見光區段的高穿透、製程上的高蝕刻選擇比及低應力特性來當此分光器之光學薄膜，並藉由微樞紐及止動微結構等輔助定位系統使其垂直於矽基板上。基於布魯斯特角及光學薄膜的性質，我們可模擬出具有高分光比的微型極化分光器。在製作三維的微元件之前，我們使用製程上較易達成的平面型極化分光器來驗證其光學特性是否符合我們的需求。接著利用微機電的面型微加工技術來製作自由空間型的立體極化分光器。量測的結果與預期的相當接近:橫向磁波的平均穿透在紅光及藍光波段可達到 89%及 50%以上，而穿透與反射的極化分光比則大約爲 9.6 及 20.9。這表示此極化分光器可有效分離橫向磁波及橫向電波，而此穿透的橫向磁波則可讀寫光碟片上的資料。此具有高光效率與極化分光比的微型化極化分光器對於應用於光學讀寫頭上是一個可行的途徑。

Micro Polarization Beam Splitter for Free-Space Micro Optical Pickups

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Abstract

MEMS-based optical pickups offer many advantages over conventional ones, including small size, light weight, high functionality and assembly steps. A free-space micro-optical pickup is consisted of many optical elements, among which polarization beam splitter (PBS) is a key component to split the light into two orthogonally polarized components, transverse electric(TE) and transverse magnetic(TM) modes. However, there is neither thin nor compact PBS that can efficiently produce polarized light and integrate with the free-space system.

The main objective of this thesis is to design and fabricate two types of SiN based micro-PBS: one is for 633 nm wavelength, the other is for 405 nm wavelength system. Silicon nitride membranes of low absorption in the visible wavelength and superior mechanical characteristic of low stress for red and blue ray application were deposited as an optical material. For the micro-optical pickup application, the design target is to have maximum transmittance of TM mode and detectable reflectance of the reflected TE mode. By choosing a proper thickness z of the thin film, the transmitted TM mode

and reflective TE mode can be easily turned to be a desired value. A sensitivity analysis was conducted for fabrication and alignment tolerances. Based on the simulations, the planar PBS for demonstrating the properties of the thin film and pop-up PBS were fabricated. At Brewster angle incidence and proper thickness of the thin film, the transmitted TM mode of micro pop-up PBS are 89% and 50 % for red and blue ray spectra, respectively. Therefore, the SiN based micro-PBS has the potential to apply in the micro optical pickup.