近場光學讀取頭中SIL/SSIL與微孔自我對準製程之研究

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摘　要

由於傳統光學讀取頭，其儲存密度受到繞射極限的限制，因此為了克服繞射極限，本研究針對利用近場光學讀取頭進行相關研究。在近場光學讀取頭中，SIL/SSIL 與微孔是主要克服繞射極限之關鍵元件；根據先前相關研究可知，將SIL/SSIL 與微孔兩元件整合在近場光學讀取頭中，可得較好的光學解析度與效能；但由於 SIL/SSIL 與微孔在整合之過程中，容易產生對準誤差，因此本研究提出一自我對準技術，用以克服在整合之過程中所產生的對準誤差；此自我對準技術，是將元件製作於玻璃基板上，籍由背向曝光步驟將此兩元件精確地對準整合。此外，本研究也提出一新型之近場光學讀取頭之整合結構包含：SIL、微孔與微金屬線圈；此近場光學讀取頭，利用微機電製程技術與 UV-LIGA 製程製作而成；籍由本研究所提出之新式製程可批次大量生產，且不需任何組裝動作，利於微小化，相較於傳統之製作方式，可大幅簡化生產流程與成本。

本研究所製作出之整合型近場光學讀取頭，其微孔直徑約為 2.88μm，由於在縮孔製程中，出現許多困難與問題，因此目前微孔無法縮至奈米大小之尺寸。籍由量測製作完成之 SIL，與設計值比較，SIL 的 sag 尺寸最大誤差值少於 2%，而其半徑尺寸之最大誤差約為 6%；由於因為在設計時，假設 SIL 為一理想半球型，但實際製作結果確為一非半球型。而利用調整 UV-LIGA 之電鍍參數，可製作出一低應力之微金屬線圈。

在本製程中，自我對準技術被証明為一可行的製程。籍由遠場量測結果可得，近場光學讀取頭光點大小，模擬與測量結果之比較，發現誤差值約 4~10%；而直徑為 60μm 與 70μm 的 SIL，分別有 30.1%與 29.1%之光點大小收縮效率。此外，SIL 在 sag 為 30μm 的情況下，仍有 50%的透光率；最後以強度為 6mW/cm^{2}之雷射，進行可靠度測試，發現經雷射破壞過之 SIL，其光學特性與表面輪廓，皆與實驗前之 SIL 幾乎完全一致。

Development of a self-alignment process between the SIL/SSIL and aperture for near-field recording pick-up head

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Abstract

Owing to the conventional optical pick-up head has diffraction limit in data storage. In order to overcome the diffraction limit, the research focuses on the optical data storage system by near-field recording (NFR). In NFR pick-up head, the SIL/SSIL and aperture are key components to overcome the diffraction limit. According to the previous research, combining the SIL/SSIL and aperture together in NFR pick-up head can obtain better optical resolution and performance. But the misalignment between the SIL/SSIL and aperture always occurred in assembling or bonding step. Hence the research here brings up the self-alignment technique to overcome the misalignment problem. The glass substrate is chosen for self-alignment technique, which is based on the backside exposure. By backside exposure step, the SIL/SSIL and aperture will be aligned precisely. Furthermore, a new integration structure of NFR pick-up head combining SIL, aperture, and microcoil is proposed. The fabrication process is based on Micro Electro Mechanical System (MEMS) and UV-LIGA technologies. This fabrication process is a batch process without assembling or bonding step. Comparing with the conventional fabrication process, the low cost and easy process step can be obtained in this process.

The aperture of diameter 2.88μm is made easily in NFR pick-up head. Owing to the shrinkage aperture step has some trouble, so the initial aperture can not shrink to nano scale. The fabrication results of SIL compared with designed values, the deviation in sag height of SIL is less than 2%, but it is about 6% in radius of SIL. Owing to the surface profile of SIL component is not a perfect hemisphere after thermal reflowing process, but the designed of SIL is assumed a perfect hemisphere. Hence we will obtain a larger deviation in radius size of SIL. The microcoil and contact pad structure with large thickness can be made with low stress by controlling the electroplating recipes.

In this research, the self-alignment technique is verified a feasible process. The measuring results of spot size compared with simulation results, we found that the deviation is 4~10%. The SIL of diameter 60μm and 70μm has 30.1% and 29.1% shrinkage efficiency, respectively. The SIL that has sag height 30μm has 50% transmission efficiency. Finally, the reliability of SIL is tested by laser that has light intensity 6mW/cm^2. The spot size calibration before and after laser destruction is conformably. Furthermore, the surface of SIL is not damaged completely.