

行政院國家科學委員會補助專題研究計畫 成果報告
 期中進度報告

新穎磁性多層膜與奈米結構之磁電效應研究-新穎磁性多層膜奈米磁區結構之
製作分析與鑄型應用元件製作(3/3)

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中文摘要

本年為三年期整合型計畫的最後一年，在過去三年研究期間，我們持續探討微磁學相關的部分，除了靜態磁區的形成與分佈，同時透過磁阻的量測，進一步的探討了主要內容涵蓋如下：透過磁力顯微儀探究奈米級磁性薄膜之磁區結構；經由磁阻量測微米級鎳鐵環的磁區動態行為；磁性多層膜之穿隧磁阻行為。尤其結合多年來對鎳鐵單層環的磁區結構瞭解，我們成功的解釋發生於磁性多層膜穿隧結相關現象。

尤其對鎳鐵環的研究，我們不僅對磁矩分佈有更進一層的認識，尤其洋蔥態及漩渦態及其相混和態的形成時機，更對尺寸效應對磁矩動態翻轉的影響有很深的瞭解與掌控，就是有關直徑、線寬、及磁膜厚度相關之上述現象也完全掌握。更進一部以電流誘致之方式特意操空磁矩動態行為，相信會有很好的未來發展。另外，對於環狀的穿隧多層膜元件的研究有豐盛的成果，我們發表了全世界第一個成功的環元件，對於一個記憶元件具有多重態的發現，相信有助於提升記憶元密度的潛力。

關鍵詞：微磁學，磁力顯微儀，鎳鐵環，磁性多層膜穿隧結，磁矩動態翻轉

Abstract

During the last three years of joint project, the micro-magnetism-related subjects have been continually studied in this sub-areas of as follow: magnetization configuration and it's evolution under external magnetic field on micro-structured permalloy ring devices; dynamic behaviors were investigated through magnetoresistance measurements; studies on the microstructured tunnel junctions in the multilayer magnetic films, especially with the ring-shaped devices. With the knowledge accumulated in the past we have successfully interpreted the reversal behavior in the magnetic tunnel junction rings.

In the first subject, we have thoroughly studied the formation of vortex, onion, and metastable states in the permalloy ring devices. Furthermore, the dynamic behavior of magnetization subjected to external magnetic field has also been investigated through magnetic force microscopy and magnetoresistance measurements. The size dependent of the domain configurations as well as the transition fields of vortex-to-onion and onion-to-vortex have been worked out in terms of the ring diameter, linewidth, and the thickness. Best of all, we have also studied the ring magnetization reversal by using current-induced magnetic field, i.e. with a current running through the ring center, which may offer an alternative and as best way of read/write technique in the field of magneto-resistive random access memory.

We have, for the first time in the world, reported the ring-shaped magnetic tunnel junction. The main subject is to work out the reversal behaviors that may give us a better idea of further applications out of this subject. Indeed, the multiple meta-stable states occurred in the reversal regions have shown promising potential for ultrahigh density of magnetic storage.

Keywords: Micro-magnetism, permalloy ring, magnetic tunnel junction, magnetization reversal

計畫成果自評

在過去三年期間，我們清楚的探究了磁性單層及多層膜的磁區結構，同時對於動態的磁區翻轉也有充分的理解。主要是透過磁力顯微儀、磁阻量測、及微磁學的模擬等方式；而技術上，我們更臻成熟於奈米製程技術，尤其電子束微影術的精進，可以說是齊頭並進。尤其，在全世界首次推出環形磁穿遂結，更讓我們有無比的信心，相信相關的實用與基礎題目，我們都可以進行探究。最可貴的是，在此期間，我們也培養數位博碩士生，碩士生有七位，博士生則有三位（與台大張慶瑞教授一起指導，張教授負責指導微磁學模擬，而由本實驗是指導微磁元件製作、量測、與分析。期間也發表三四十篇期刊論文，就國際曝光度與人才培育而言，本計畫是成功的。感謝國科會的支持，也感謝彰化師大的大力配合與支持。

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