摘 要

本論文主要在探討鋨金屬的成長及加入磁性多層膜後之特性研究。當一層超薄的鋨金屬層加在鈷鐵/鋨錳合金介面時，其鈷鐵的矯頑場及磁滯曲線方正性可以在 400℃ 退火後還維持和初鍍膜狀態相近。此鈷鐵/鋨/鋨錳薄膜，在歐傑電子縱深分析中，亦可發現鋨錳層內的錳原子並未擴散進入鈷鐵層，此結果說明鋨金屬具有作為錳的擴散阻隔層的潛力。

在非晶質的二氧化矽基板上成長鈷鐵/銥錳薄膜時，需加入鋨金屬作為緩衝層，方可使得鈷鐵/銥錳薄膜成長出 fcc(111)指向，並產生交換場。因為鋨為六方最密堆積結構 (hcp)，其底面的(0002)面和 fcc 結構中的(111)面具有相同的原子排列方式,因此,以銅作為種子層並藉由金屬-金屬磊晶成長法 (MMES method)可在氫終結的矽(100)及矽(111)基板上，成長出具有明顯 fcc(111)指向的鈷鐵/銥錳織構薄膜。當鍍製鈷鐵/銥錳薄膜時，鋨金屬在矽(100)及矽(111)基板上會形成不同的表面型態，甚至，銥錳在鈷鐵/銥錳/鋨/銅/矽(100)中，會隨著鋨的厚度增加，而改變其晶體結構從(002)改變成(111)。此具有較佳結晶性的鈷鐵/銥錳薄膜，會形成較佳的磁滯曲線方正性，而使得磁矩的翻轉過程變得具有較佳的一致性。此鈷鐵/銥錳織構薄膜，會於 250℃ 得到最大交換場並於 350℃ 退火後使得其交換場消失，相較於非織構的鈷鐵/銥錳薄膜，其產生最大交換場及交換場消失的溫度，分別往上提升 50℃ 及 75℃，另外，當此織構鈷鐵/銥錳薄膜的介面上再增加一超薄的鋨金屬層時，亦可使得其退火後的交換場大於初鍍膜的狀態。這些結果顯示，藉由加入鋨緩衝層及鋨擴散阻隔層後，鈷鐵/銥錳薄膜會得到較佳的熱穩定性。

最後，當選用適當的種子層，具有高 hcp (0002)指向性且具有六重對稱性的鋨金屬膜可以分別在室溫下以磁控濺鍍的方式成長於氫終結的矽(100)及矽(111)基板上。使

用銅金屬在氫終結的矽(100)基板上作為種子層，可大幅將晶格常數的不匹配性自大於30%降低至小於 7%，而成長出具有雙晶結構且具有微弱六重對稱性的鈦金屬膜。此時可觀察到一特殊的平面十二重對稱性，來自於以[0002]方向為軸且彼此相差 90 度的磊晶晶粒。另外，當選用銅/金作為種子層時，可在氫終結的矽(111)-1x1 表面上成長出具有良好六重對稱結構的鈦金屬膜，從其 XRD 的φ-san 中有六根高強度的繞射峰，更可證明此具有六重對稱性的鈦金屬膜之成長是可以被操控的。根據上述特性，鈦金屬具有很高的應用潛力且可於磁穿隧接面記憶胞製程及超大型積體電路製程間作為一重要的整合媒介。

Abstract

This dissertation is mainly to study the growth of osmium (Os) and the properties of magnetic films with an Os layer. By insertion an ultrathin Os layer between CoFe/OsMn interface, the coercivity (H_c) and hysteresis squareness (S) of samples after annealing below 400°C can retain nearly the same value of that at as-deposited state. In the CoFe/Os/OsMn system, as revealed from the AES depth profile, the Mn atoms in OsMn layer did not enter the CoFe layer, and this result indicated the Os layer had potential to act as the diffusion barrier of Mn atoms.

The CoFe/IrMn films on SiO_2 substrate without Os buffer layer did not show the IrMn fcc (111) and the CoFe fcc (111) peaks and its exchange field (H_{ex}) is almost zero. Since Os is a hexagonal close-packed (hcp) metal and its basal (0002) plane has the same atomic arrangement of a (111) plane in fcc. When the Os layer deposited by metal-metal epitaxy on silicon (MMES) method with a Cu seed layer on the hydrogen-terminated Si substrate, the texture CoFe/IrMn could be grown, and a clear fcc (111) peak was observed. The Os layer on H-Si (100) and H-Si (111) shows different surface mesh for CoFe/IrMn growth. The structure of IrMn in CoFe/IrMn/Os/Cu/Si(100) can turn from (002) to (111) during increasing the thickness of Os layer. The much better crystallinity of the CoFe/IrMn showed better S, thus, the switching process of magnetization was more coherent. The textured CoFe/IrMn reached its $H_{ex, max}$ at 250°C, while the H_{ex} vanished at 350°C. Compared with the non-textured CoFe/IrMn, the 50°C and 75°C of improvement on the temperature at which the $H_{ex,max}$ appeared and the H_{ex} disappeared were remarkable, respectively. For all the samples with an Os barrier, its CoFe/IrMn showed larger H_{ex} than that of the as-deposited state. These mean that a CoFe/IrMn film can have a better thermal stability with adding an Os diffusion barrier

layer and an Os buffer layer.

Finally, by choosing the appropriate buffer layers, high-oriented hcp (0002) with 6-fold symmetry Os films can be grown on hydrogen-terminated Si (100) and Si (111) substrates by magnetron sputtering at room temperature, respectively. Using a Cu buffer layer, the lattice mismatch between Os (0002) and Si (100) was significantly reduced from >30% to ~7%, and thus Os films can grow with twin relationships and weak 6-fold symmetries. A 12-fold in-plane symmetry resulted from two sets of (0002) epitaxial grain rotated by 90° with respect to each other along [0002] direction was observed. On the other hand, the Cu/Au buffer layer was selected to form an fcc (111) surface mesh on H-Si (111)-1x1. The 6 high intensity peaks of XRD φ scan diffraction were measured and which indicated the 6-fold Os (0002) can be well controlled. According to the properties mentioned above, Os do have high application potential and play an important role on integrating the ULSI and MTJ processes.

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