在鈦酸鍶(110)基座上成長單晶鑭鍶錳氧薄膜與X光Φ角繞射分析之研究

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摘 要

本論文選擇La0.7Sr0.3MnO3(LSMO)為靶材，並以射頻磁控濺鍍的方式，在SrTiO3(110)單晶基板上成長La0.7Sr0.3MnO3薄膜，再進而討論樣品在不同外加磁場、不同的溫度下，其物理特性的改變，我們使用X-ray θ-2θ繞射分析薄膜結晶結構及判斷磊晶垂直薄膜平面成長方向，及利用Φ角繞射來分析薄膜平面排列方向以及其有序度。 本論文分三個部分，首先是LSMO薄膜成長在STO(110)與STO(001)基座之晶體結構分析，第二是不同成長溫度對於LSMO特性之影響，第三是各向異性之探討。 1.我們可以得到在STO(110)上成長具單晶優選結構之LSMO薄膜。 2.在不同成長溫度下，其成長溫度Tg與居禮溫度Tc有一定成長趨勢；當成長溫度越高，平整度越差；藉由施瑞爾方程式可推知，當其成長溫度增加，其晶粒越大，其結果與平整度相同。 3.在成長溫度為600 oC之LSMO薄膜成長在STO(110)基座上之樣品，外加磁場為H=0.8 T時，當H//[1 0]、I//[001]時的Tm值小於H//[001]、I//[1 0]時的Tm值。在磁組討論可發現，沿著不同方向[1 0]、[001]量測出之磁阻比，在[1 0]方向上有較大的磁阻比。

關鍵詞 : 鈣鈦礦 ; 鑭鍶錳氧 ; Φ角繞射 ; 布拉格定律 ; 射頻磁控濺鍍 ; 單晶 ; 磁阻

目錄

The target of this thesis is the La0.7Sr0.3MnO3(LSMO) film grow on the single crystal substrate of SrTiO3(110) with RF magnetron sputtering. This thesis also discusses the physics characteristics of La0.7Sr0.3MnO3(LSMO) film under different external applied magnetic field and temperatures. We use the powder X-ray diffraction θ-2θ to analyze the structure of film crystal and to judge the growth direction of epitaxy vertical film surface. In addition, we utilize Φ scan to analyze the arrangement direction of film surface and its order. This thesis divides into three parts. First of all, the results are the growth of LSMO film and the crystal structure analysis on STO(110) and STO(001). Secondly, it shows that how the different growth temperatures affect on LSMO characteristics. At last, it contains the discussion of the differences. 1. We can grow the preferred single crystal structure of LSMO film on STO(110). 2. There must be certain growth tendency between growth temperature Tg and Curie’s temperature Tc under different growth temperatures. The higher the growth temperature is, the larger the surface roughness is. According to Scherrer Equation, it has the same result as the surface roughness because when the growth temperature is increased, the crystal is bigger. 3. The sample of LSMO film grows on STO(110) at 600 oC growth temperature and the external applied field is H=0.8 T. When it is under H//[1 0]、I//[001], Tm is lower than it is under H//[001]、I//[1 0].It can be discovered that the Magnetoresistance ratio in the direction of [1 0] is higher than that in the direction of [001].

參考文獻

[1] R.Von.Henlmolt,J.Wecker,K.Samwer,Phy.Bl 50,640(1994) [2] S.Jin, T.H.Tiefel, M.McCormak, R.A. Fastnacht, R. Ramesh and L. H. Chen, Science 264. 413 (1994) [3]S.Jin,T.H.Tiefel,R.M.Fleming,J.M.Phillip,andR.Ramesh,Appl. Phys.Lett.64,3045 (1994).
[4] K.K.Chio and Y.Yamazaki, “ Substrate-Dependent Micro- structure and Magnetoresistance of La-Sr-Mn-O Thin Films Grown by RF Sputtering ”,Jpn.J.Appl. Phys.Vol.38,(1999), p.56-60.
[5] S.P.Isaac, N.D.Mathur, J.E.Evetts, and M.G.Blamire Department of Materials Science, University of Cambridge, Pembroke Street,Cambridge CB2 3QZ United Kingdom, ” Magnetoresistance of artificial La0.7Sr0.3MnO3 grain boundaries as a function of misorientation angle ”, Applied Physics Letters Volume 72, Number 16, 20 April (1998),p.2038-2040 [6] Young Suk Cho, “ Magnetoresistance of La1-xSrxMnO3 films deposited by RF magnetron co-sputtering ”,Journal of Magnetism and Magnetic Materials 226-230(2001) p.754-756 [7] M. N. Baibich, J. M. Broto, A. Fert, F. Nguyen Van Dau, F. Petroff, P. Etienne, G. Greuzet, A. Friederich, and J. Chazelas, Phys. Rev. B, Vol. 61, 2472(1988).
[8] 張慶瑞,中華民國磁性技術協會會訊,第十九期，1999,p.5 [9] Robert C. O’Handley,Modern Magnetic Materials Principles and Applications (John Wiley & Sons,New York,2000) [10] J. Baszynski , T. Tolinski , B. Idzikowski , D.M. Tobbens , A. Hoser J . Baszynski et al . / Journal of Alloys and Compounds 345 (2002) 210—213 ” Structural effects of grinding on La0.7Sr0.3 MnO3 ceramic studied by neutron diffraction “ [11] C. Zener,Phys. Rev. 82 403(1951) [12] M. Julliere, Phys. Lett. 54A, 225 (1975) [13] Soshin Chikazumi,Physics of Ferromagnetism (Whiley,New York,1964) p.3 [14] Charles Kittel "Introduction to Solid State Physics 4th ed." 'Chap.14-15 ' John Wiley& Sons. Inc. (1996) [15] B.D. Cullity,Introduction to Magnetic Materials (Addison-Wesley,Massachusetts,1972) p.85 [16] B. D. Cullity,Elements of X-ray

Diffraction (Addison-Wesley,Massachusetts,1977) [17]許樹恩,吳泰伯,X 光繞射原理與材料結構分析,中國材料科學 [18] Intel co. Embedded Microcontrollers 1995.
[19] Intel co. MCS-51 Family of Single Chip Microcomputers User ” s Manual.
[20] Intel co. Introducing to MCS-51 Boolean Processor.
[21] Intel co. 8051 Single Chip Microcomputer Architectural Specification and Functional Description.
[22] 蔡柏樟 視窗51模擬實務 知行文化 (2003) [23] 楊鴻昌，物理專文『認識超導量子干涉元件SQUID』，物理雙月刊11卷5期。
[24] 楊鴻昌，超導、超導—應用篇『最敏感的感測元件SQUID及其前瞻性應用 』，物理雙月刊24卷5期。