Investigation of Characteristics for Al/LPD-SiO2/Ge MOS Device

林東賢、黃俊達 ; 姚品全

E-mail: 9805478@mail.dyu.edu.tw

ABSTRACT

The liquid-phase-deposition (LPD) oxide has been grown on Ge substrate under room temperature by using an aqueous solution of supersaturated hydrofluosilicic acid (H2SiF6) and boric acid (H3BO3). Before depositing silicon dioxide (SiO2), the Ge wafers were treated with (NH4)2Sx solution and it was found that the leakage current can be improved. In this study, the as-grown LPD samples were annealed at 200, 300 and 400°C for 30 minutes under N2 environment to improve their electrical properties. We found that the breakdown voltage was increased, fixed oxide charge and interface trap densities were reduced. The current-voltage (I-V) and capacitance-voltage (C-V) characteristics were investigated to determine their electrical properties.

Keywords : Ge, LPD, MOS、(NH4)2S

Table of Contents

授權書...iii 中文摘要.......................................iv 英文摘要.......................................v 誌謝...vi 目錄...vii 圖目錄...ix 表目錄...xii 第一章 緒論...................................1 第二章 理論...................................2 2-1 金屬-氧化層-半導體(MOS).....................2 2-2液相沉積....................................11 (A)LPD-SiO2簡介................................11 (B) LPD的化學成長反應..........................12 第三章 實驗方法及量測..........................14 3-1 材料分析...................................14 (A) 蒸鍍機系統.................................14 (B) 爐管退火...................................15 (C) 膜厚量測...................................16 (D) 傅利葉轉換紅外光譜儀(FTIR)..................17 (E) 化學分析電子儀(ESCA)........................17 3-2 MOS元件製作過程.............................18 (A)基板的清洗步驟...............................18 (B) 硫化處理...................................19 (C) 歐姆電極的製程..............................19 (D) 成長LPD-SiO2薄膜............................19 (E) 氧化層的沉積與爐管退火......................22 (F)閘極電極的製作...............................22 第四章 結果與討論..............................24 4-1 LPD-SiO2薄膜厚度量測結果....................24 4-2 材料分析結果................................25 (A) 化學分析電子儀..............................25 (B)傅利葉轉換紅外光譜儀（FTIR）.................29 4-3 LPD-SiO2 MOS元件I-V電特性...................30 4.-4 MOS之電容-電壓分析.........................33 (A) 簡介.......................................33 (B) Al/LPD-SiO2/n-Ge的電容特性研究..............36 (C)MOS之固定氧化層電荷密度......................37 (D)MOS之介面缺陷密度............................38 第五章 結論....................................41 參考文獻.......................................42 圖目錄 圖2-1 簡易的電容示意圖..........................2 圖2-2 金氧半二極體的結構圖......................3 圖2-3偏壓下金氧半二極體電容的能帶圖.............4 圖2-4 VG=0 的理想MOS 二極體之能帶圖.............5 圖2-5 N 型半導體表面之能帶圖....................6 圖2-6 N型MOS 二極體，表面電位與載子變化之情況....7 圖2-7 N型半導體之理想MOS C-V 曲線...............9 圖2-8 N型MOS二極體電容效應之等效電路圖..........10 圖3-1 爐管退火系統..............................15 圖3-2 α-step量測方式示意圖.....................16 圖3-3 液相沉積法系統圖..........................21 圖3-4 元件製作流程..............................23 圖4-1 LPD-SiO2不同六氟矽酸之沉積速率............24 圖4-2 未退火LPD-SiO2之Si(2p)的 XPS圖............25 圖4-3 未退火LPD-SiO2之O(1s)的 XPS圖.............26 圖4-4 未退火LPD-SiO2之F(1s)的 XPS圖.............26 圖4-5 未退火LPD-SiO2之S(2p)的 XPS圖.............27 圖4-6 無硫化處理之 XPS分析圖....................28 圖4-7 硫化處理之 XSP分析圖......................28 圖4-8 未退火LPD- SiO2之紅外光譜吸收圖...........29 圖4-9 LPD- SiO2之不同濃度比較...................30 圖4-10 有無硫化處理之IV比較.....................31 圖4-11 無硫化後之不同溫度IV比較.................32 圖4-12 影響氧化層電性之電荷來源圖...............33 圖4-13 LPD-SiO2之高頻量測C-V電性圖..............36 圖4-14 LPD-SiO2-200 oC高低頻之C-V電性圖.........38 圖4-15 LPD-SiO2-300 oC高低頻之C-V電性圖.........39 圖4-16 LPD-SiO2-200 oC高低頻之C-V電性圖.........39 表目錄 表4-1 退火溫度與固定氧化層電荷密度關係表.........37 表4-2退火溫度與介面缺陷密度關係表................40

REFERENCES

[1] D.J.Paul, adv. Mater. 11, 191-204 (1999) [2] H. Shang, et al., IEEE Elect. Dev. Lett. 24, 245 (2003).

[3] C. O. Chui, et al.,IEDMTech. Dig., 437, 2003.

[4] Appl. Phys. Lett., vol. 79 ,pp. 3344-3346, 2001.

[5]P. Kringhoj, A. N. Larsen, and S. Y. Shirayev, Phys. Rev. Lett., 76, 3372 ~1996!.

[6]K. Rajendran and W. Schoenmaker, J. Appl. Phys., 89, 980 ~2001! [7]M. P. Houng, C. J. Huang and Y. H. Wang, J. Appl. Phys., Vol 82, pp.5788, 1997.
[8]M. P. Houng, Y. H. Wang, C. J. Huang, S. P. Huang, and W. J. Chang, Solid-State Electronics, Vol. 44, pp. 1917, 2000.
[9]Jenq-Shiuh Chou, Si-Chen Lee, J. Appl. Phys., Vol 77, No.4 (1995) [10]P. J. Wright, and K. C. Saraswat, Fellow, IEEE Transactions On Electron Device, Vol. 36, No. 5, pp.879 (1989).
[11] C. Y. Yeh, S. S. Lin, T. Z. Yang, C. L. Chen, and Y. C. Yang, IEEE Transactions On Electron Devices, Vol. 41, No. 2, pp. 173 (1994).
[12]W. J. Chang, M. P. Houng, and Y. H. Wang, Jan. J. Appl. Phys., Vol. 40, No. 3A, pp.1300 (2001).
[13] C. F. Yeh, C. L. Chen, W. Lur, and P. W. Yen, Appl. Phys. Lett., Vol. 66, No. 8, pp.938 (1995).