Exoploration of the hafnium oxide films grown by thermal oxidation

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ABSTRACT

In this thesis, hafnium was using thermal oxidation to the preparation of metal oxide for the rare earth element hafnium metal. Hafnium metal was deposited on silicon wafer by E-Gun and then proceeded with thermal oxidation in high temperature furnace tube for various oxidation temperature (600°C~900°C).The Capacitance-voltage (C-V) characteristic curve was measured by LCR Meter (1 MHz) high-frequency range and calculated for each sample of the oxide dielectric constant (ε) are greater than 25.By the instrument HP4156C measurements when the bias is -1V, the samples leakage current density are less than 10-7 A/cm2 and the breakdown field strength are more than 9 MV/cm. The greater thickness of oxide film was obtained for the longer oxidation temperature by the transmission electron microscopy (TEM) measurement. The surface morphology of hafnium oxide films was measured by atomic force microscope (AFM). From the macro point of view, the grown oxide films of which thickness, surface roughness (Ra) vary with oxidation temperature. The crystal structure, showing tetrahedral shape into six-sided cone (Hexahedron) extent that octahedral pyramid (Octahedron), the nuclei of hafnium oxide started growing from the bottom (substrate surface) and gradually stacking up into a taper, there are similarities between the present pattern after rolling through the taper tip, the measure on surface of the oxidation films by Nanoscope III.目錄 封面內頁 簽名頁 中文摘要. . . . . iii Abstract. . . . . iv 誌謝. . . . . v 目錄. . . . . vi 圖目錄. . . . . viii 表目錄. . . . . xi 第一章　緒論　1.1研究背景. . . . . 1　1.2研究方法. . . . . 2　1.3論文結構. . . . . 3 第二章　文獻回顧　2.1高介電薄膜介紹. . . . . 4　2.1.1材料的選擇. 5　2.2 HfO2薄膜特性. . . . . 6　2.3 MOS製程特性與基礎 . . . . 7　2.3.1 N-channel金氧半場效電晶體(NMOS) . . . . 8　2.3.2 P-channel金氧半場效電晶體(PMOS) . . . . 10　2.3.3 臨界電壓. . . . . 11　2.4氧化層薄膜物理特性. . . . . 11 第三章　熱氧化法應用於氧化鉿薄膜之研究　3.1前言. . . . . 13　3.2實驗規劃. . . . . 13　3.2.1二氧化矽(SiO2)薄膜製備. . . . . 14　3.2.2二氧化矽(SiO2)薄膜電氣特性. . . . . 15　3.3厚度30A與100 A的鉿金屬氧化物薄膜製備. . . . 16 第四章　結果與討論　4.1 X-Ray繞射儀(XRD)對氧化鉿晶體結構的探討. . . 18　4.2穿透式電子顯微鏡(TEM)對氧化鉿結構橫剖面的 探討. . . . . 20　4.3氧化鉿薄膜表面粗糙度(Surface Roughness)的量測. 22　4.4 X-Ray光電子頻譜儀(XPS)量測與分析. . . . . . 31　4.5氧化鉿薄膜束縛能能階(Binding Energy)之分析與　探討. 38　4.6氧化鉿的電容—電壓特性. . . . . 43　4.7氧化鉿的電流—電壓特性. . . . . 44 第五章　結論與未來方向　5.1結論. . . . . 46　5.2未來研究方向. . . . . 46 參考文獻. 48

Keywords : hafnium oxide、transmission electron microscopy (TEM)、atomic force microscope (AFM)、surface roughness (Ra)

Table of Contents

目錄 封面內頁 簽名頁 中文摘要. . . . . iii Abstract. . . . . iv 誌謝. . . . . v 目錄. . . . . vi 圖目錄. . . . . viii 表目錄. . . . . xi 第一章　緒論　1.1研究背景. . . . . 1　1.2研究方法. . . . . 2　1.3論文結構. . . . . 3 第二章　文獻回顧　2.1高介電薄膜介紹. . . . . 4　2.1.1材料的選擇. 5　2.2 HfO2薄膜特性. . . . . 6　2.3 MOS製程特性與基礎 . . . . 7　2.3.1 N-channel金氧半場效電晶體(NMOS) . . . . 8　2.3.2 P-channel金氧半場效電晶體(PMOS) . . . . 10　2.3.3 臨界電壓. . . . . 11　2.4氧化層薄膜物理特性. . . . . 11 第三章　熱氧化法應用於氧化鉿薄膜之研究　3.1前言. . . . .

. . . . 13 3.2實驗規劃. 13 3.2.1二氧化矽(SiO2)薄膜製備. . . . . 14 3.2.2二氧化矽(SiO2)薄膜電氣特性. . . . . 15 3.3厚度30A與100 A的鉿金屬氧化物薄膜製備. . . . 16 第四章 結果與討論 4.1 X-Ray繞射儀(XRD)對氧化鉿晶體結構的探討. . . 18 4.2穿透式電子顯微鏡(TEM)對氧化鉿結構橫剖面的 探討. . . . . 20 4.3氧化鉿薄膜表面粗糙度(Surface Roughness)的量測. 22 4.4 X-Ray光電子頻譜儀(XPS)量測與分析. . . . . . 31 4.5氧化鉿薄膜束縛能能階(Binding Energy)之分析與 探討. . . . . 38 4.6氧化鉿的電容—電壓特性. . . . . 43 4.7氧化鉿的電流—電壓特性. . . . . 44 第五章 結論與未來方向 5.1結論. . . . . 46 5.2未來研究方向. . . . . 46 參考文獻. 48

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