鍺鎢合金非揮發性記憶體

之製作及研究

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摘要

對最廣為使用的非揮發性記憶體 — 快閃記憶體而言，通常會遇到兩個瓶頸：一是在元件尺寸繼續微縮下之瓶頸，由於尺寸微縮後穿隧氧化層(或閘極氧化層)之厚度亦隨之下降，如此雖可得到較快的讀寫速度，但電荷保存時間亦隨之下降，故須在兩者之間取得平衡點；二是在多次讀寫後在穿隧氧化層品質容易劣化而產生漏電路徑，一旦有一條產生，所有儲存在浮動閘極(floating gate)的電荷都會經由此漏電路徑而全部流失掉。為了克服上述兩個瓶頸，主要有兩種改良的的方法被提出，一是 SONOS 非揮發性記憶體，另一種是奈米晶體(量子點)非揮發性記憶體。

在本文中，提出一個新的材料及不同結構來製作非揮發性記憶體。金屬半導體化合物已被廣泛應用在研究製作金屬奈米點非揮發性記憶體或者SONOS非揮發性記體，在本研究中，選擇金屬鎢與半導體鍺做為材料，因為鎢與鍺已被廣泛應用在半導體製程上，因此此兩種材料在半導體工業上有很大的相容性；在結構中我們探討鎢/鍺堆疊結構和鎢-鍺混合薄膜兩種製作方式,希望藉由一系列的熱處理後，完成一個新材料的非揮發性記憶體來探討其儲存的效應。在鎢-鍺混合薄膜的

結構當中，在正負 10V的掃描電壓下，我們可以得到 11V的記憶窗口且其保存能力在經過十年後其記憶窗口仍有 67%。在鎢/鍺堆疊結構的結構中，我們以在退火前疊上一層二氧化矽成功改善其記憶窗口、漏電流、保存能力等特性，在記憶窗口上約增為兩倍，其漏電降低 10^8，也增加其保存仍力約 10^2倍。

Fabrication and study on $Zr_{1-x}Ge_x$ for nonvolatile memory devices

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Abstract

For nonvolatile semiconductor memories (NVSM), there are two limitations encountered at the present time. (1) The limited potential for continued scaling of the device structure: this scaling limitation stems from the extreme requirements on the tunnel oxide layer. To balance between program/erase speed and retention time, there is a trade-off between speed and reliability for the optimal tunnel oxide thickness. (2) The quality and strength of tunnel oxide (or tunnel dielectric) after plenty of program/erase cycles, once a leaky path has been created in tunnel oxide, all charges stored in the floating gate will be lost. Therefore, two approaches, the silicon-oxide-nitride-oxide-silicon (SONOS) and the nanocrystal nonvolatile memory devices, have investigated to overcome this oxide quality limit of the conventional floating gate NVSM.

In this study we proposed a mew materials and different structures to fabricate for NVMS. Metal-Semiconductor has been popularly investigated for the application on nanocrystal nonvolatile memory device and the silicon-oxide-nitride-oxide-silicon. In this study we choice conductor Zr and semiconductor Ge because Zr and Ge have been popularly application for semiconductor process. Hence, Zr and Ge have heavy compatibility very at semiconductor industry. We discus two different structure to fabricate Zr/Ge double layer and Zr-Ge mixed layer as charge trapping layer. We hope that after several different thermal processes, a new materials nonvolatile memory was completed. The memory effect was we study.

The memory windows for the MONOS structure with Zr-Ge co-sputtering layer as charge trapping layer after RTA treatment at the condition, 500C for 30sec in nitrogen ambient is 11V under ±10V bidirectional voltage sweep. There are still 67% memory window after decade.

In Zr/Ge double layers structure we capped a SiO2 to improve the memory effect, leakage current and retention characteristics successfully. The memory increase two times, the leakage current reduce eight order and the retention increase two order.