臨場濕式氧化方法在金屬鎢奈米點非揮發性記憶體之製作與研究

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摘要

非揮發性記憶體(NVM)目前在元件尺寸持續微縮下的需求為高密度記憶單元、低功率損耗、快速讀寫操作、以及良好的可靠度(Reliability)。傳統浮動閘極(floatinggate)記憶體在操作過程中如果穿隧氧化層產生漏電路徑會造成所有儲存電荷流失回到矽基板，所以在資料保存時間(Retention)和耐操度(Endurance)的考量下，很難去微縮穿隧氧化層的厚度。非揮發性奈米點記憶體被提出希望可取代傳統浮動閘極記憶體，由於奈米點可視為電荷儲存層中彼此分離的儲存點，可以有效改善小尺寸記憶體元件多次操作下的資料儲存能力。近年來發展了許多方法來形成奈米點，一般而言，大多數的方法都需要長時間高溫的熱製程，這個步驟會影響現階段半導體製程中的熱預算和產能。

臨場濕式氧化方法是一種引入少許氫氣的濕式氧化過程，由於氫氣可以幫助產生更多的氧自由基，所以它相較於乾式氧化或快速升溫氧化法有更快的氧化速率，而且許多的文獻已證實用臨場濕式氧化方法所製作的氧化層有較好的品質與可靠度。在本論文中，我們利用臨場濕式氧化方法來製作鎢奈米點記憶體，分別應用在穿隧氧化層和奈米點的形成，並且和快速升溫氧化法做比較。另外，我們也將臨場濕式氧化方法的溫度、氧化時間、氫氣含量對於鎢奈米點形成的影響做詳細的探討與研究。

Study and Fabrication on the Tungsten metal Nanocrystals Nonvolatile Memory by the Application of the In-Situ Steam-Generation (ISSG)

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Abstract

Current requirements of nonvolatile memory (NVM) are the high density cells, low-power consumption, high-speed operation and good reliability for the scaling down devices. However, all of the charges stored in the floating gate will leak into the substrate if the tunnel oxide has a leakage path in the conventional NVM during endurance test. Therefore, the tunnel oxide thickness is difficult to scale down in terms of charge retention and endurance characteristics . The nonvolatile nanocrystal memories are one of promising candidates to substitute for conventional floating gate memory, because the discrete storage nodes as the charge storage media have been effectively improve data retention under endurance test f or the scaling down device. Many methods have been developed recently for the formation of nanocrystal. Generally, most methods need thermal treatment with high temperature and long duration. This procedure will influence thermal budget and throughput in current manufacture technology of semiconductor industry.

The in-situ-steam-generation-process (ISSG) oxidation process is a wet oxidation with some hydrogen introduced in it. It has a faster oxidation rate than dry

and RTO oxidation due to more oxygen radicals produced by hydrogen. Because of its quick oxidation rate, ISSG provides excellent quality of thin oxide and many references have demonstrated that ISSG oxide shows much better reliability property than dry or RTO oxide. In this thesis, we apply ISSG to fabricate our tungsten nanocrystals nonvolatile memory. The applications are on the tunneling oxide fabrication and nanocrystals formation, respectively. The comparisons were made between the ISSG and RTO oxidation methods. The effects of ISSG temperature, oxidation time and H2 contents on tungsten nanocrystals formation are also investigated in our study.

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